

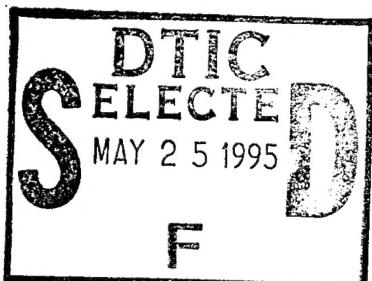


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**SCIENCE AND TECHNOLOGY**  
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TECHNICAL REPORT  
NATICK/TR-94/026

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## **INTEGRATED UNIT SIMULATION SYSTEM: METABOLIC WORK RATE SUPPORT STUDY**



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## **Preface**

This research was sponsored by the U.S. Army Natick Research, Development and Engineering Center, Concepts Analysis Division, Advanced System Directorate, Natick , MA. The contract number was DAAK60-93-K-0001, under the Broad Agency Announcement Solicitation. Mr. John O'Keefe was the technical manager and Mrs. Elaine Scarnici was the contracts specialist for the effort.

# **INTEGRATED UNIT SIMULATION SYSTEM: METABOLIC WORK RATE SUPPORT STUDY**

## **1.0 INTRODUCTION**

The development of an automated Integrated Unit Simulation System (IUSS) is in the design stage. The IUSS is in the process of being populated with various tools which will assist the user, developer and system designer with the investigation of the equipment needs for the soldier of the future. This system extends the modeling capability to look at the individual soldier's performance in a combat environment with ballistic and chemical threats.

We have reached the level of modeling sophistication that we can now look more deeply into the performance of the soldier, to portray an individual's task performance in various environments and investigate the outcomes based on the performance options presented to the soldier and do this for many individuals in a combat scenario.

The IUSS simulates combat according to the Battlefield Operating Systems (BOS) tasks as defined in the Army Training and Evaluation Program and Mission Training Plans (ARTEP/MTPS), ensuring a common framework for analysis, training and combat operations by enhancing communication within the soldier/weapon system design process. The IUSS represents the mission capabilities and the soldier status throughout the simulated mission. The mission is represented as a set of networks with the nodes of the network presented as BOS tasks. The soldiers' performance status is represented by a physiological baseline of core temperature, hydration level, heart rate and level of performance degradation as output.

The information gained from this modeling can be used to design clothing and equipment, and to develop training or change doctrine based on the needs of the soldier. Of course, inputs in the form of quantitative data and equations are required to provide a certain level of validation for IUSS. One of the required inputs is the metabolic work rate of military tasks performed over an extended period of time. As the soldiers are tracked through the network of the IUSS, their physical status is displayed while the task environment changes.

### **1.1 Objective of Study**

One of the problems encountered while preparing the soldier system of IUSS was the representation of the metabolic work rate of the soldier as the work rate relates to specific tasks and the ability to vary a work rate over different levels of tasking for long periods of time. Work rate is defined as the total energy expenditure of the body per unit of time, also referred to as metabolic workload.

The US Army Research Institute of Environmental Medicine (USARIEM) is in the process of developing a Metabolic Task Inventory based on empirical measures of task performance, but this inventory will not be complete until late 1994. The IUSS requires a method for representing task/metabolic work rate data within the next six months.

This study was initiated to develop a method of calculating the metabolic work rate for the type and duration of tasks for the total time the soldier is in the field. This calculation becomes an input to the soldier status system of IUSS to determine core temperature, fatigue levels and effects of load-bearing equipment and protective clothing on soldier performance.

To meet this task, four objectives were initiated:

Review the industrial/commercial/military literature for methods, modeling representations and data on metabolic work rate.

Develop a useful algorithm and methodology for calculating work rate based on task time performance of soldiers during an 8 to 12 hour combat environment.

Assist the Government with the insertion of the metabolic work rate formula(e) into the IUSS.

Prepare a preliminary report of the findings, with recommendations as to the best metabolic work rate method to use with IUSS.

## **1.2 Assumptions for Development and Use of the Algorithm with IUSS**

Most of the prediction models of physiological performance tend to underpredict both heart rate and oxygen uptake. These models have historically been based on load carriage while using a treadmill for data collection. Most of the data to validate these models are from field studies, which means there is a change in pace, load carriage is not smooth or accurate and negotiation of the walkway in the field is very different from the treadmill. Therefore, changes to the algorithm must be assumed to account for the field environment.

This method is a very small, but important part of the soldier status system and must be empirically validated with information from the USARIEM program being conducted at Natick, Ma.

The particular method selected may be a composite of different methods or a very simplistic procedure based on the ability to fit the code into the module which will interact with the entire soldier system program of IUSS.

The method of assigning work rate to various tasks to test the algorithm needs validation. A procedure of weighting the work based on mostly dexterous and gross motor tasks has had limited use in the past. The measurement of purely cognitive tasking (decision making, planning etc.) as a measure of work rate requires different methods for determining the energy cost because cognitive tasking is not a matter of movement of musculature, the energy expenditure involves being seated or standing and may be considered as a task which requires very little metabolic work load.

## 2.0 METHOD

### 2.1 Literature Search

A search of on-line databases was conducted to find research performed to date on metabolic work rates and algorithms or models for predicting work rate. Only commercial databases were included in this search since DoD sources were gathered from the Defense Technical Information Center (DTIC). The list in Table 1 includes the databases searched within DIALOG. Appendix A contains a brief description of each database.

**Table 1. Database Listing**

AEROSPACE DATABASE	MECHANICAL ENGINEERING ABSTRACTS
AMERICAN MEDICAL ASSOCIATION	MEDLINE
JOURNALS ONLINE	NATIONAL NEWSPAPER INDEX
BIOSIS PREVIEWS	NEWSEARCH
DISSERTATION ABSTRACTS ONLINE	NTIS
EICOMPENDEX*PLUS	PASCAL
EMBASE (formerly EXCERPTA MEDICA)	SCISEARCH
ENERGY SCIENCE AND TECHNOLOGY	SPORT
FLUIDEX (FLUID ENGINEERING ABSTRACTS)	STANDARDS AND SPECIFICATIONS
HEALTH PERIODICALS DATABASE	TOXLINE
IHS INTERNATIONAL STANDARDS AND SPECIFICATIONS	TRADE AND INDUSTRY ASAP
INSPEC	TRADE AND INDUSTRY INDEX
INTERNATIONAL PHARMACEUTICAL ABSTRACTS	WORLD TRANSLATION INDEX

The search strategy included the following keywords: metabolic, work rate, physiological, physical, watts, kilocalorie, models, exertion, fatigue, exhaustion, demand, capacity and human performance.

The results of the database search produced titles and abstracts which contained the keywords. The abstracts were reviewed and relevant documents ordered. The bibliography (Appendix B) lists all the articles reviewed on metabolic work rate. The references contain information documenting relevant research and/or metabolic work rate algorithms or models which are listed in the matrix in the following section.

### 2.2 Decision Matrix

The dissertations found from the database search provided an extensive review of the literature on metabolic algorithms, particularly Taboun's dissertation. Twenty-four models were found from the search which calculated metabolic work rate in one form or another. Garg's (1978) model was found to be the most comprehensive model documented in the literature. Konz's (1990) algorithm also accounted for a variety of activities, but the activity metabolism is taken from a table of thirty activities, or a known metabolic rate. The objective of this project was to establish an algorithm which calculates the metabolic work rate of soldiers for the variety of tasks they perform. The metabolic work rates are not known for all those tasks, and more importantly, the work rate is dependent on the individual. Konz's model does not meet this objective because of its limited activities.

Table 2 lists all the equations/algorithms/models found in the literature. A matrix shown in Table 3 indicates the tasks each algorithm models.

**Table 2. Metabolic Work Rate Models**

Model	Task(s)	Equation(s)	Input(s)	Output(s)	Comments
Aberg et al. (1968)	lifting	$\text{VO}_2 = \text{BWn}(k1) + \text{BWcl}(k2) + \text{BWcl}[\text{GCBh}(k3) + \text{GCBv}(k4)] + (\text{WWP} + \text{WT})[\text{Lha}(k5) + u(\text{Lhc})(k6) + \text{Lvu}(k7) + \text{Lvd}(k8)]$	$\text{BWn}$ = body wt naked (kg) $\text{BWcl}$ = body wt w/ clothing (kg) $\text{GCBh}$ = horiz displacement per time unit of body's CG (meters) $\text{GCBv}$ = vertical displacement per time unit of body's CG (meters), + up, - down $\text{WWP}$ = wt of workpiece (kg) $\text{WT}$ = wt of tool (kg) $\text{Lha}$ = horiz displacement per time unit of tool and workpiece, arm work (meters) $\text{Lhc}$ = horiz displacement per time unit of tool and workpiece, carrying or dragging (meters) $\text{Lvu}$ = upward vertical displacement per time unit of tool and workpiece - lifting (meters) $\text{Lvd}$ = downward displacement per time unit of tool and workpiece - lifting (meters) $u$ = coefficient of friction $k1-k8$ constants	$\text{VO}_2$ = oxygen uptake (L/min)	doesn't consider container size  dynamic lifting  $k1$ basal metabolism $k2$ sitting/standing $k3$ walking $k4$ bending and rising $k5$ horiz transport of material (arm working) $k6$ horiz transport of material (carrying) $k7$ lifting upwards $k8$ lifting downwards

**Table 2. Metabolic Work Rate Models (Cont'd)**

Model	Task(s)	Equation(s)	Input(s)	Output(s)	Comments
Asfour (1980)	lift/lower	$\text{VO}_2 = 545.7538 - 106.77(\text{TA}) + (\text{FY})(\text{L}^2)(35002.65\text{L})10^{-5} + 17.47(\text{FY})(\text{L})(\text{HT1})(\text{WT})(\text{WID})(\text{LEN})(\text{ANG})10^{-5} + 6435.22(\text{WT})(\text{FY}^2)10^{-5}$ $\text{VO}_2 = 371.5055 - 51.9573(\text{TA}) + (\text{WT})(\text{FY}^2)(31856.54 - 2332.8\text{FY})10^{-5} + 12684.91(\text{FY})(\text{L}^2)10^{-5} + 12.31(\text{FY})(\text{HT2})(\text{L})(\text{WID})(\text{LEN})(\text{ANG})10^{-5}$	$\text{TA} = \text{task (1=lift; 2=lower)}$ $\text{FY} = \text{freq of lift/lower (times/min)}$ $\text{L} = \text{load (lbs)}$ $\text{HT1} = \text{height lift/lower above floor (inches)}$ $\text{HT2} = \text{height lift/lower above table (inches)}$ $\text{WID} = \text{box width (inches)}$ $\text{LEN} = \text{box length (inches)}$ $\text{ANG} = \text{angle of twist (1 for 0 degrees, 2 for 90 degrees)}$ $\text{WT} = \text{body weight (lbs)}$	$\text{VO}_2 = \text{ml/min}$	eqn 1: start/end at floor level eqn 2 start/end at table higher than 30"
Buskirk, Nicholas and Hodgson (1975)	treadmill walking cranking shoveling stepping lifting gripping	$\text{METS} = 0.017(\text{WT}) + 0.019(\text{HR}) + 0.116(\text{Ve}) - 3.0419$ simplified equation: $\text{METS} = 0.145(\text{Ve}) - 0.353$ or $\text{kcal} = 0.06(\text{WT}) + 0.025(\text{HR}) + 0.158(\text{Ve}) - 6.94$	$\text{WT} = \text{body weight (kg)}$ $\text{HR} = \text{heart rate (beats/min)}$ $\text{Ve} = \text{minute ventilation (L/min)}$	METS METS kcal/min	eqns developed from activities of 9 healthy men ages 21-56 at 3 WBGT (26.7C, 29.4C and 32.2C) not good predictor for overweight individuals
Datta et al (1973)	carry weight on head	$\text{cost} = 6.58(\text{wt} + \text{load}) - 152$	body wt (kg) load (kg)	metabolic cost (watts)	carry only 0-50 kg used only 51 kg subject

**Table 2. Metabolic Work Rate Models (Cont'd)**

Model	Task(s)	Equation(s)	Input(s)	Output(s)	Comments
Evans et al. (1983)	load held or carried in front of body	$IHR(H) = 7.75 + 0.95F$ $IHR(C) = 31.6 + 0.6F$	$F = \text{wt of load (kg)}$	$IHR(H) = \text{mean heart rate increases at exhaustion for load holding}$ $IHR(C) = \text{mean heart rate increases at exhaustion for load carrying}$	doesn't consider box characteristics or body weight
Frederik (1959)	lifting	$E = (f)(a)(wt)(c)/1000$	$f = \text{no. lifts/hr}$ $a = \text{lifting height (feet)}$ $wt = \text{wt of load (lbs)}$ $c = \text{consumption of energy in gm-calories/l-lb}$	$E = \text{kcal/hr}$	$E < 200 \text{ kcal/hr}$ $c$ from graph at certain lifting range single lift (not dynamic lifting) body wt and box size not considered

**Table 2. Metabolic Work Rate Models (Cont'd)**

Model	Task(s)	Equation(s)	Input(s)	Output(s)	Comments
Garg et al. (1978)	sitting standing lifting squatting walking carrying holding pushing pulling arm movement	$\Sigma E_{\text{job}} = (\sum^n E_{\text{pos}} \times t_i + \sum^n \Delta E_{\text{task}_i})/T$	$E_{\text{pos}}$ = metabolic energy expenditure due to maintenance of ith posture (kcal/min) $t_i$ = time duration of ith posture (min) $n_t$ = total no. body postures employed in job $\Delta E_{\text{task}_i}$ = net metabolic energy expenditure of ith task in steady state (kcal) $n$ = total no. tasks in given job $T$ = time duration of job (min)	$E_{\text{job}}$ = ave energy expenditure rate of job (kcal/min)	$\Delta E$ eqns provided for various tasks dry bulb 21-25C RH 50-58% any inaccuracy in description of work will significantly affect the metabolic workrate estimate for entire job summing steady state of individual tasks not verified (Asfour (1980) showed not valid for lift/lower) container not considered height ranges other than 0-32" and 32"-60" not considered

**Table 2. Metabolic Work Rate Models (Cont'd)**

Model	Task(s)	Equation(s)	Input(s)	Output(s)	Comments
Intarantont (1983)	lifting	$AT = (41171892.555 + 1.439(WT)(FY) - 3461.837(PB) - 11.744(WT^2) - 3771.16(WT)(R) + 24.964(LBW^2))10^{-5}$ $AT = (157396.895 - 21.615(WT)(FY) - 1611.729(PA) + 2.113(WT^2))10^{-5}$	$WT = \text{body wt (lbs)}$ $FY = \text{freq of lifts (lifts/min)}$ $LBW = \text{lean body wt (lbs)}$ $R = LBW/WT$ $PB = PWCB (1000)(2.2046)/LBW (ml/kg (LBW) - min)$ $PWCB = PCW \text{ determined by bicycling (L/min)}$ $PA = PCQA (1000)(2.2046)/LBW (ml/kg(LBW) - min)$ $PWCA = PWC \text{ determined by arm cycling (L/min)}$	$AT = \text{anaerobic threshold (L/min)}$	eqn 1 floor to knuckle height eqn 2 knuckle to shoulder height
Konz (1990)	various activities	$TOTMET = BSLMET + ACTMET + SDAMET$ $BSLMET = BSMET(WT)$ $ACTMET = ACMET(WT)$ $SDAMET = 0.1(BSLMET + ACTMET)$	$BSLMET = \text{basal metabolic rate}$ $ACTMET = \text{activity metabolic rate}$ $SDAMET = \text{specific dynamic action metabolic rate}$ $BSMET = 1.28 \text{ watts/kg males; } 1.16 \text{ watts/kg females}$ $WT = \text{body wt (kg)}$ $ACMET = \text{activity metabolism/kg (watts/kg)}$	$TOTMET = \text{total metabolic rate (watts)}$	use table in Konz text or known metabolic rate; SDAMET = due to digestion

Table 2. Metabolic Work Rate Models (Cont'd)

Model	Task(s)	Equation(s)	Input(s)	Output(s)	Comments
Konz (1990)	various activities	$TOTMET = 60 \text{ ENERGY}$ (OXUPTK)	ENERGY = energy equivalent of 1 liter $O_2$ (watts-hr/liter)  OXUPTK = oxygen uptake $VO_2$ (liter of $O_2$ )	$TOTMET$ = total metabolism (watts)	ENERGY (depends on respiratory quotient, which depends on proportion of fat vs. carbohydrate metabolized during exercise) = 5.36 for RQ = .83 (rest) 5.66 for RQ = .86 (exercise up to 60% max) 6.4 for RQ = 1.0 (100% max)  applicable for lab setting where these measurements can be taken
Mahadeva et al. (1953)	not stated	$E = 0.197M + 4.27 \text{ kJ/min}$	$M$ = body mass (kg)	energy	at a pace of 4.8 km/hr input units are not additive
Morrissey and Liou (1984)	carry load between arms and in front of body	$M = 75.14 + 3.11(W) + (2.72L + 87.75)V^2 + 13.36(W + L)(L/W)$	$L$ = wt carried (kg) $V$ = treadmill speed (m/sec) $W$ = body wt (kg)	$M$ = metabolic rate (watts)	not for intermittent carrying tasks
Pandolf et al. (1976)	walking	$walkin = C(2.7 + 3.2(v-0.7))^{1.65}$	velocity (m/sec) $c$ = terrain coefficient	metabolic cost (watts/kg of body weight)	$c$ = terrain coefficient: 1.0 treadmill/blacktop 1.1 dirt road 1.2 light brush 1.3 hard packed snow ( $c = 1.3 + 0.082$ , foot depression, cm) 1.5 heavy brush 1.8 swamp 2.1 sand
Pandolf et al. (1977)	backpack load carriage	$M = 1.5 + 2.0(W + L)(L/W)^2 + n(W + L)(1.5V^2 + 0.35VG)$	$W$ = subject's wt (kg) $L$ = external load (kg) $V$ = speed walking (m/sec) $G$ = grade (%) $n$ = terrain coefficient ( $n = 1$ treadmill)	$M$ = metabolic rate (watts)	only for load on back

Table 2. Metabolic Work Rate Models (Cont'd)

Model	Task(s)	Equation(s)	Input(s)	Output(s)	Comments
Passmore and Draper (1965)	various	$E = 4.92V(20.93 - O_e)$ $E = 5 \text{ kcal/min} = 1 \text{ L } O_2/\text{min}$	$V = \text{volume of expired air (L/min)}$ $O_e = O_2 \text{ percentage concentration of expired air}$	$E = \text{energy (kcal/min)}$	
R.M. Ross and A.S. Jackson (1986)	walking	$\text{MET} = 75 + (6)(\%)$	$75 = \text{horizontal work constant (MET min/mile)}$ $6 = \text{vertical work constant (MET min/mile/%)}$ $\% \text{ percent grade (slope)}$	$\text{MET min/mile}$	data based on 58 men temperature, RH and wind not accounted for equation does not account for individual or velocity treadmill or hard surface walking
Ralston (1958)	walking	$E_w = 32 + 0.0050v^2$	$v = \text{velocity (m/min)}$ $b, m = \text{constants}$	$E_w = \text{energy expenditure (cal/min/kg)}$	treadmill, floor firm path, grass constants b and m determined from data/equations from various investigators (57 men/29 females)
Randle (1987)	carrying load	$M = 1.25(GV^2) + 0.1(47.33G + 87.75L + 21.96W + 197.51V)$	$G = \text{treadmill gradient (\%)}$ $V = \text{walking velocity}$ $L = \text{load wt (kg)}$ $W = \text{body wt (kg)}$	$M = \text{metabolic rate (kcal/h)}$	intermittent load carrying in arms (carry load every other 30 sec while walking continuously)
Shephard (1982)	level walking	$E = 5.36V + 2.09 \text{ kJ/min}$	$V = \text{velocity (km/hr)}$	energy	input units are not additive
Taboun (1986)	carrying	$VO_2 = 0.3458 + [(BW + L)(1.4468)(BW + L) + 14.325(F)(D) + (388.826(L)(F))10^{-5}]$	$BW = \text{body wt (kg)}$ $L = \text{load (kg)}$ $F = \text{freq (handling/min)}$ $D = \text{carrying distance (meters)}$	$VO_2 = \text{oxygen consumption (L/min)}$	individual intermittent carrying tasks load held between arms and in front of body best used when $L = 8-28$ ; $D = 0-12$ ; $F = 1-5$

**Table 2. Metabolic Work Rate Models (Cont'd)**

Model	Task(s)	Equation(s)	Input(s)	Output(s)	Comments
Taboun (1986)	carrying/lifting	$VO_2 = 0.1809 + [(BW + L)(2.6112(BW + L)(92.594(DH)) + F(318.16L + 7.9815(BW)(D) + 49.1565(L)(D))]10^{-5} + 2.2956(WID/L)$	BW = body wt (kg) L = load handled (kg) F = frequency D = carrying distance (meters) H = height range of lift (meters) WID = box width along sagittal plane (meters)	$VO_2$ = oxygen consumption (L/min)	individual carrying and/or combined carrying and lifting from 75 cm (table height, up to height of 150 cm or less)  best used when $L = 8-28$ ; $F = 1-5$ ; $D = 0-12$ ; $H = 0-1.5$ ; $WID = 0.15-0.55$
Taboun (1986)	carrying/lifting	$VO_2 = 0.0738 + [(BW + L)(3.9918)(BW + L) + 61.226(D)(H) + (L)(F)(424.131 + 81.926D)]10^{-5} + 3.851(WID/L)$	BW = body wt (kg) L = load handled (kg) F = frequency D = carrying distance (meters) H = height range of lift (meters) WID = box width along sagittal plane (meters)	$VO_2$ = oxygen consumption (L/min)	combined lifting and carrying tasks; lifting starts from floor to 150 cm or less  best used when $L = 8-28$ ; $F = 1-5$ ; $D = 0-12$ $H = 0-1.5$ ; $WID = 0.15-0.55$
Van der Walt & Wyndam (1973)	running	$runm = 0.142/M + 11 + 0.04v^2$	V = velocity (km/h)	metabolic cost (watts/kg of body weight)	M = ? not defined
Van der Walt & Wyndam (1973)	walking	$walkin = 2 + 0.124v^2$	V = velocity (km/h)	metabolic cost (watts/kg of body weight)	

**Table 2. Metabolic Work Rate Models (Cont'd)**

Model	Task(s)	Equation(s)	Input(s)	Output(s)	Comments
Winter (1979)	body movements (i.e. walking)	$E(i) = m(i)gh(i) + 0.5m(i)v(i)^2 + 0.5I(i)w(i)^2$ $W_{wb} = \sum^N  \sum^S \Delta E(i,j)  \text{ joules}$	$m(i)$ = segment's mass (kg) $v(i)$ = segment's absolute translational velocity relative to some datum (m/sec) $h(i)$ = segment's vertical position relative to some datum (m) $I(i)$ = segment's moment of inertia about its mass centroid ( $\text{kg m}^2$ ) $w(i)$ = segment's absolute angular velocity (rad/sec) $g$ = force due to gravity $\Delta E(i,j)$ = total energy change during (i)th segment $N$ = total number of sample periods during one study $S$ = total number of segments modelled	$E(i)$ = total energy of (i)th segment $W_{wb}$ = energy transfer between and within segments	instantaneous energy level of any segment (i)

**Table 2. Metabolic Work Rate Models (Cont'd)**

Model	Task(s)	Equation(s)	Input(s)	Output(s)	Comments
Zarraugh et al. (1974)	walking	$E_w = E_0 / [(1-s^2/s_u^2)(1-n^2/n_0^2)]$ for natural walking eqn becomes: $E_w = E_0 / (1-v/v_u^2)$	$s$ = step length (meters) $n$ = step rate (steps/min) $E_0 = E_w$ when $s=n=0$ (ave value 28 cal/min/kg) $s_u$ = upper limit of $s$ as $E_w$ goes to infinity $n_u$ = upper limit of $n$ as $E_w$ goes to infinity $v$ = speed $v_u$ = upper limit of $v$ , equal to $n_u s_u$ (ave value 240 m/min)	$E_w$ = cal/min/kg	accounts for step length and rate

Table 3. Model Summary Matrix

Model	walk/ run	carry	hold	stoop	bend/ squat	lift	lower	sit	stand	push	pull	crank	shovel	step	grip	various/ not stated
Aberg						x										
Asfour						x	x									
Buskirk, Nicholas and Hodgson	x					x						x	x	x	x	
Datta																
Evans		x	x													
Frederik																
Garg	x	x	x	x	x	x	x	x	x	x	x					
Intaranout							x									
Konz																x
Mahadeva																x
Morrissey and Liou			x													x
Pandolf (1976)	x															
Pandolf (1977)		x														
Passmore and Draper																x
Ralston	x															
Randle		x														
Ross and Jackson	x															
Shephard	x															
Taboun		x														
Taboun					x											
Van der Walt & Wyndam	x															
Van der Walt & Wyndam	x															
Winter	x															
Zarrough	x															

### 3.0 Results

The results of the literature search revealed three possible methods which could be of use to IUSS. Garg's model, Konz's model (already converted to a software package) and Christensen's nomograph. Garg's equations for various postures are provided and Konz's method for determining work rate (based on VO<sub>2</sub> consumption) is listed. Christensen's nomograph was selected as the best procedure to use with the IUSS. The Energy Expenditure Table (Table 7) was developed using Christensen's work and adding Borg's perceived expenditure method. The nomograph was used to evaluate selected tasks, included in the evaluation are two tasks which were measured during the Metabolic Task Inventory study. These empirical data were analyzed using the same procedure to see if actual data could be used for acquiring metabolic work rate using the Energy Expenditure Table.

#### 3.1 Garg's Model

$$\Sigma E_{job} = (\sum n^t E_{pos} \times t_i + \sum n \Delta E_{taski})/T$$

where

$E_{job}$  = average energy expenditure rate of entire job (kcal/min)

$E_{pos}$  = metabolic energy expenditure due to maintenance of ith posture (kcal/min)

$t_i$  = time duration of ith posture (min)

$n^t$  = total no. body postures employed in job

$\Delta E_{taski}$  = net metabolic energy expenditure of ith task in steady state (kcal)

$n$  = total no. tasks in given job

$T$  = time duration of job (min)

#### Maintenance of body postures

sitting

$$E_{pos} = 0.023 \text{ BW}$$

standing

$$E_{pos} = 0.024 \text{ BW}$$

standing, bent position

$$E_{pos} = 0.028 \text{ BW}$$

#### Net Metabolic Cost of Tasks

stoop lift (kcal/lift)

$$\Delta E = 10^{-2} [0.325 \text{ BW} (0.81-h1) + (1.141L + 0.76S \times L) (h2 - h1)] \text{ for } h1 < h2 \leq 0.81$$

squat lift (kcal/lift)

$$\Delta E = 10^{-2} [0.514 \text{ BW} (0.81-h1) + (2.19L + 0.62S \times L) (h2-h1)] \text{ for } h1 < h2 \leq 0.81$$

one hand lift (kcal/lift)

$$\Delta E = 10^{-2} [0.352 \text{ BW} (0.81-h1) + 3.03L(h2-h1)] \text{ for } h1 < h2 \leq 0.81$$

arm lift (kcal/lift)

$$\Delta E = 10^{-2} [0.062 \text{ BW} (h2-0.81) + (3.19L - 0.52S \times L)(h2-h1)] \text{ for } 0.81 < h1 < h2$$

stoop lower (kcal/lower)

$$\Delta E = 10^{-2}[0.268 \text{ BW} (0.81-h1) + 0.675 (h2-h1) + 5.22 \text{ S} (0.81-h1)] \text{ for } h1 < h2 < 0.81$$

squat lower (kcal/lower)

$$\Delta E = 10^{-2}[0.511 \text{ BW} (0.81-h1) + 0.701L (h2-h1)] \text{ for } h1 < h2 > 0.81$$

arm lower (kcal/lower)

$$\Delta E = 10^{-2}[0.093 \text{ BW} (h2-0.81) + (1.02L + 0.37 \text{ S} \times L) (h2-h1)] \text{ for } 0.81 < h1 < h2$$

walking (kcal)

$$\Delta E = 10^{-2}(51 + 2.54 \text{ BW} \times V^2 + 0.379 \text{ BW} \times G \times V)t$$

carrying, loads held at arms length at sides (in one or both hands) (kcal)

$$\Delta E = 10^{-2}[80 + 2.43 \text{ BW} \times V^2 + 4.63L \times V^2 + 4.62L + 0.379(L + \text{BW})G \times V]t$$

carrying, loads held against thighs or against waist (kcal)

$$\Delta E = 10^{-2}[68 + 2.54 \text{ BW} \times V^2 + 4.08L \times V^2 + 11.4L + 0.379(L + \text{BW})G \times V]t$$

holding, at arms length, against thighs or at sides (both hands) (kcal)

$$\Delta E = 0.037 L \times t$$

holding, against waist (kcal)

$$\Delta E = 0.062 L \times t$$

holding, at arms length in one hand (kcal)

$$\Delta E = 0.088 L \times t$$

pushing/pulling, at bench height (0.8 meters) (kcal/push)

$$\Delta E = 10^{-2} X(0.112 \text{ BW} + 1.15F + 0.505 \text{ S} \times F)$$

pushing/pulling, at 1.5 meter height (kcal/push)

$$\Delta E = X(0.086 + 0.036F)$$

lateral movement of arms 180 degrees, both hands (kcal/lateral movement of arms)

$$\Delta E = 10^{-2} (0.11 \text{ BW} + 0.726L)$$

lateral movement of arm 180 degrees, one hand (kcal/lateral movement of arm)

$$\Delta E = 10^{-2} (0.097 \text{ BW} + 0.946L)$$

lateral movement of arms 90 degrees, standing, one or both hands (kcal/lateral movement of arms)

$$\Delta E = 10^{-2}(3.31 + 0.629L + 0.143 \text{ S} \times L)$$

lateral movement of arms 90 degrees, sitting, both hands (kcal/lateral movement of arms)

$$\Delta E = 10^{-2}(3.5 + 0.682L + 0.321 \text{ S} \times L)$$

lateral movement of arm 90 degrees, sitting, one hand (kcal/lateral movement of arm)

$$\Delta E = 10^{-2} (2.54 + 1.1L + 0.248 \text{ S} \times L)$$

forward movement of arms, standing, one or both hands (kcal/movement of arms)

$$\Delta E = 10^{-2} X(3.57 + 1.23L)$$

forward movement of arms, sitting, one or both hands (kcal/movement of arms)

$$\Delta E = 10^{-2} X(6.3 + 2.71L)$$

where

E = metabolic rate (kcal/min)

$\Delta E$  = kcal for walking, carrying and holding. For all other tasks, units are  
Kcal/performance

BW = body weight (kg)

F = average pushing/pulling force applied by hands (kg)

G = grade of the walking surface

h<sub>1</sub> = vertical height from floor (meters); starting point for lift and end point for lower

h<sub>2</sub> = vertical height from floor (meters); end point for lift and starting point for lower

L = weight of the load (kg)

S = gender; 1 for males, 0 for females

V = speed of walking (meters/sec)

X = horizontal movement of work piece (meters)

t = time (minutes)

Garg's model takes into consideration the gender and body weight of the individual, as well as the parameters of the task being performed (distance, speed, grade, how a load is carried/moved in the hands/arms, etc.). The output of the algorithm is metabolic energy in kcal/min (1 kcal/min = 6.978 watts).

The model is simplified to specific postures and tasks or movements. A separate equation was developed for each defined posture and task. The metabolism for the postures of sitting, standing and standing bent are based on body weight. Tasks such as sitting, standing, lifting, lowering, squatting, walking, carrying, holding, pushing, pulling and arm movements are modeled by Garg's algorithm. The metabolic work rates for each of these postures and movements are summed to determine the total metabolic work rate for the entire task.

Military tasks can be defined using Garg's equations, but the task must be specified precisely. An inaccurate description of work using the defined postures and movements will affect the resulting metabolic estimate for the task.

Garg's model has limitations that must be considered. The lifts/lowers are modeled to occur lower than 0.81 meters in height. This does not account for tasks that require lifting an object above the shoulders and head. Carrying an object in front of the body is modeled, but soldiers also carry backpacks. This was not modeled by Garg.

Even though these equations are additive, they do not consider the fact that the individual may have just performed a task and not totally recovered from the first task (i.e., fatigue, increased heart rate, etc.)

### 3.2 Konz' Model

Basal Metabolism

$$\text{BASLMET} = \text{BSMET} (\text{WT})$$

where

$$\text{BASLMT} = \text{basal metabolism, W}$$

$$\text{BSMET} = 1.28 \text{ W/kg for males}$$

$$= 1.16 \text{ W/kg for females (difference due to body fat)}$$

$$\text{WT} = \text{body weight, kg}$$

Dubois surface area:

$$\text{DBSA} = .007184 (\text{HT})^{.725} (\text{WT})^{.425}$$

where DBSA

$$= \text{DuBois surface area, m}^2$$

$$\text{WT} = \text{weight, kg}$$

Correction for DuBois prediction inaccuracies:

$$\text{SA} = .208 + .945 (\text{DBSA})$$

$$= .208 + .006789 (\text{HT})^{.725} (\text{WT})^{.425}$$

where SA

$$= \text{surface area m}^2$$

$$\text{DBSA} = \text{DuBois surface area, m}^2$$

Basal metabolism per m<sup>2</sup> of surface area:

$$\text{BMMALE} = 64.95 - .8875 \text{ A} = .0078 \text{ A}^2 (5 < \text{A} < 70)$$

$$\text{BMFMLE} = 59.43 - .9315 \text{ A} + .0076 \text{ A}^2 (5 < \text{A} < 70)$$

where BMMALE

$$= \text{basal metabolism for males, W/m}^2$$

$$\text{BMFMLE} = \text{basal metabolism for females, W/m}^2$$

$$\text{A} = \text{age, years}$$

Calculate basal metabolism:

$$\text{BASLMT} = \text{BMMALE} (\text{SA})$$

$$= \text{BMFMLE} (\text{SA})$$

Activity metabolism is:

$$\text{ACTMET} = \text{ACTFMT} (\text{WT})$$

where ACTMET

$$= \text{activity metabolism, W}$$

$$\text{ACTFMT} = \text{activity metabolism factor, Wkg}$$

$$\text{WT} = \text{weight, kg}$$

When metabolism is measured:

$$\text{TOTMET} = 60 \text{ energy (OXUPTK)}$$

where TOTMET

$$= \text{total metabolism, W (usually just basal + activity)}$$

$$\text{ENERGY} = \text{energy equivalent of 1 liter of oxygen, W-hr/liter}$$

Depends on respiratory quotient (RQ) which in turn depends upon the proportion of fat vs. carbohydrate metabolized during the exercise. Astrand and Rodahl indicate a RQ of .86 is satisfactory for exercise up to about 60% of maximum oxygen uptake; then RQ goes to 1.0 as uptake goes to 100%.

For resting, RQ

$$= .83$$

$$\text{OXUPTK} = \text{oxygen uptake, } \text{VO}_2, \text{ liters of oxygen/min}$$

Pulmonary ventilation is:

$$\text{PULVNT} = (\text{LAPLOX}) (\text{OXUPTK})$$

where PULVNT = liters of air/min  
LAPLOX = liters of air/liter of oxygen  
= 20-25 at rest and for work less than 15 W/min  
= 30-35 during maximal work

Vital capacity (an index of an individual's lung capacity), the maximum that can be exhaled following a maximum inspiration, can be estimated with a standard deviation of 10% as:

$$\begin{aligned}\text{VITALC(male)} &= 56.3 (\text{HT}) - 17.4 (\text{A}) - 4210 \\ \text{VITALC(female)} &= 54.5 (\text{HT}) - 10.5 (\text{A}) - 5120\end{aligned}$$

where VITALC = vital capacity (standing), mL  
HT = height, cm  
A = age, years

Heart rates determined by metabolic load (as opposed to emotions or vasodilatation in heat) are highly correlated with incremental metabolic rates; that is given one you can predict the other. The linear equation does have different coefficients for different individuals and different types of work:

$$\text{INCHR} = K = .12 \text{ INCMET}$$

where INCHR = increase in heart rate, beats/min  
= constant = 2.3 for wrm work only  
= - 11.5 for walking or walking + arm work  
INCMET = increase in metabolism, W

Due to venous pooling in the legs, arm work without leg work requires 14 more beats/min than leg work at the same metabolic rate.

Heart rate, a good index of task difficulty, can be estimated accurately by asking the individual to provide a perceived exertion level. This perceived exertion scale (Table 4) was designed to be 10% of the heart rate to interpret actual beats per minute by multiplying the subjective estimate of exertion by ten.

**Table 4. Perceived Exertion for Heart Rate Prediction**

Numerical Predictor	Subjective Description
6	very light
7	very light
8	very light
9	very light
10	light
11	light
12	light
13	moderate
14	moderate
15	hard
16	hard
17	very hard
18	very hard
19	extremely hard
20	extremely hard

### **3.3 Christensen's Nomograph**

A method of measuring pulse rate (heart rate) as described by Astrand (1954) and Christensen (1953) to determine work expenditure in industry is the most applicable to the IUSS as a metabolic work rate input method. This nomograph represents the total work expenditure and not just the portion related only to physical work. Using this method, one can calculate the energy requirement of a job by breaking the job into tasks or subtasks. The limitation to this nomograph as with all of the models is the affect of heat dissipation of the body when wearing MOPP gear. The effect on task performance in MOPP must be accounted for by the addition of increased heart rate added to the heart rate used for the task in MOPP0. The increased heart rate would address the work the body does to remove the heat from the body and the change in respiration when wearing the protective mask.

The data from Table 5 have appeared in the literature over the past five decades and continues to be the benchmark used by physiologists as the basis for their models of physiological (dexterity and gross motor) performance. By using this nomograph and combining the data with the perceived exertion scores for determining heart rate, the algorithm to represent the various work rates to use in IUSS is achievable.

**Table 5. Energy Expenditure Nomograph**

Work Level	Energy k/cal/min	Males beats/min	Females beats/min	Rectal Temp C°	O <sub>2</sub> L/min
Very Light	< 2.5	< 75	85	< 37.5	0.5
Light	2.5 - 5.0	75 - 100	85 - 110	37.5	1.0
Moderate	5 - 7.5	100 - 125	110 - 135	37.5 - 38.0	1.5
Hard	7.5 - 10	125 - 150	135 - 165	38.0 - 38.5	2.0
Very Hard	10 - 12.5	150 - 175	165 - 185	38.5 - 39.0	2.5
Extremely Hard	> 12.5	> 175	> 185	> 39.0	3.0

### **3.4 Task Calculations**

The following is an example using the nomograph method for calculating the total job for a preselected set of infantry tasks. Since one of the jobs depicted in IUSS is Occupy Assembly Area, tasks were selected from the task listing to use as the test case. The infantry tasks and the Occupy Assembly Area tasks are provided in Appendix C.

The kcal/min from the nomograph was changed to watts/hour (1 kcal/hr = 1.163 watt) for this example. Each category of energy expenditure was linearly scaled to the watts for work rate, the beats per minute for the heart rate and the subjective perceived exertion scores. The times assigned for task performance are based on subject matter experts suggested times for the tasks. The construction of such a table based on the task performance for the purpose of modeling the tasking within the IUSS is the simplest and believed to be the best method for the programmers to use to develop the required module. This method may have application to the soldier in the field, since he would be able to judge how hard he is working by taking his pulse and determining energy expenditure, especially when wearing MOPP gear.

To examine how applicable this table is to empirical data, USARIEM was consulted to see if any of the tasks they measured during the Metabolic Task Inventory study matched any of the tasks we were looking at. There were two tasks which matched the ones selected for the analysis. These tasks were: Maintain M-16 Rifle and Construct Individual Fighting Position. The empirical data are presented with the calculated data taken from the Energy Expenditure Table. The empirical data, provided in Table 6, are reported in V<sub>O<sub>2</sub></sub> (Liters per min) and heart rate (beats per minute)<sup>\*</sup>. The data presented in Table 8 were converted to energy expenditure using the Energy Expenditure Table (Table 7).

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\* Information provided by John Patton, MTI Test Director

**Table 6. Empirically Measured Tasks**

Maintain Rifle(male)	VO <sub>2</sub> L/min	Heart Rate(bpm)(female)	VO <sub>2</sub> L/min	Heart Rate(bpm)
MOPP0	0.88 ) .12	107 ) 13	0.54 ) .09	108 ) 21
MOPP4	1.04 ) .23	124 ) 10	0.58 ) .08	118 ) 21

Construct Individual

Fighting Position (male)	VO <sub>2</sub> L/min	Heart Rate(bpm)(female)	VO <sub>2</sub> L/min	Heart Rate(bpm)
MOPP0	1.33 ) .18	122 ) 13	0.88 ) .07	128 ) 13
MOPP4	1.49 ) .28	131 ) 18	0.95 ) .14	135 ) 12

Using the Energy Expenditure Table, heart rate column and selecting the watts associated with the corresponding heart rate to accomplish the tasks these tasks are considered light to moderate. When these numbers are input into Konz' tables, they provide approximately the same watts of expended energy. This, in a small way, validates the utility of the energy expenditure table. More data will be required to provide a thorough validation, but it is clear that for modeling purposes this table will provide the programmer what is required for the input of metabolic work rate into the individual soldier module. For more precise data, one needs to consult Konz' software or Garg's algorithm. This model asks for height and weight of individual and type of task being performed and is based on VO<sub>2</sub>.

**Table 7. Energy Expenditure Table**

Type of Work	Energy Expenditure (watts)	Heart Rate Male/Female (bpm)	Perceived Exertion Scale (M/F)
Very Light	105	60/60	6/6
Very Light	115	64/64	6.5/6.5
Very Light	125	68/73	6.5/7
Very Light	150	72/79	7/8
Very Light	175	75/85	7.5/8.5
Light	176	77/86	7.5/8.5
Light	200	79/91	8/9
Light	225	83/97	8.5/9.5
Light	250	87/99	8.5/10
Light	275	91/103	9/10
Light	300	96/107	9.5/10.5
Light	350	100/110	10/11
Moderate	375	102/112	10/11
Moderate	400	104/114	10.5/11.5
Moderate	425	110/119	11/12
Moderate	450	113/123	11/12
Moderate	475	116/128	11.5/12.5
Moderate	500	121/131	12/13
Moderate	525	125/135	12.5/13.5
Hard	550	126/137	12.5/13.5
Hard	575	128/139	12.5/14
Hard	600	131/149	13/15
Hard	625	136/150	13.5/15
Hard	650	141/154	14/15.5
Hard	675	146/160	14.5/16
Hard	700	150/165	15/16.5
Very Hard	725	154/167	15.5/16.5
Very Hard	750	157/168	15.5/16.5
Very Hard	800	163/172	16/17
Very Hard	825	168/175	16.5/17.5
Very Hard	850	172/181	17/18
Very Hard	875	175/185	17.5/18.5
Extremely Hard	900	180/190	18/19
Extremely Hard	925	185/195	18.5/19.5
Extremely Hard	950	197/210	19.5/21
Extremely Hard	975	211/220	21/22
Extremely Hard	1000	220/230	22/23

**Table 8. Task and Energy Expenditure Data for IUSS**

Assembly Tasks	Watts Used for Task	Heart Rate (bpm/sd)	Performance Time	Task Type
Camouflage Equipment	425	110	25 minutes	Moderate
Maintain M16 Rifle	298 300	m: 107/±13 f: 108/±21	15 minutes	Light Light
Select Fighting Positions	237	85	15 minutes	Light
Construct Individual Fighting Position	450 475	m: 122/±13 f: 128/±13	60 minutes	Moderate Moderate
Send Radio Message	115	65	3 minutes	Very Light
Construct M60 Fighting Position	650	140	60 minutes	Hard
Deploy Chemical Agent Detectors	350	100	30 minutes	Light
Establish Observation Post	350	100	5 minutes	Light
Conduct Area Reconnaissance	525	125	60 minutes	Moderate
Conduct Local Security Patrol	525	125	60 minutes	Moderate
Perform Road Guide Duties	300	96	120 minutes	Light
Perform Search and Scan Procedures	225	85	5 minutes	Light
Engage Hostile Aircraft with Small Arms	675	145	2 minutes	Hard

## 4.0 Discussion

The analysis of the Occupy Assembly Area tasks indicates work rate can be determined easily and effectively by using the nomograph. We can gather the information using the software tool developed by Konz, if we have very specific data and if we need even greater specificity we can use Garg's method. Garg's method would be applicable in a laboratory environment or when a detailed task analysis was required for specific procedures.

The Energy Expenditure Table can be used in different ways. If empirical data are available (heart rate) then the corresponding work rate can be selected from the table. If perceived exertion data from soldiers performing the tasks is obtained the exertion score can be converted to a work rate. If only a verbal term is available (light, moderate or hard) then a random selection from the work rate column for that term can be made.

Physiological researchers may be concerned that this procedure of selecting work rate is too simplistic, but remembering the many variables which make up work rate; the approach selected to interact with the heat model in IUSS provides the level of data required without complex calculations which were designed for much more specific types of work studies.

This method also has application in some of the other ongoing programs. If one wanted to determine work rate for dexterity tasks or gross motor tasks or a combination of both this method is applicable. There is a change in heart rate and therefore, in work rate for small muscle (dexterous) tasks as discussed in Section 3.2 of this report.

When the empirical data were used with the Energy Expenditure Table, the energy expenditure was easily selected. The empirical data are being collected ( $VO_2$  and heart rate) by USARIEM and will be converted into the energy expenditure. The equation or table of equations was not known when the information was obtained from USARIEM for this analysis, this means there may be a slight variation in the expenditure based on the conversion method used. It is not believed there will be much difference between the method presented in this report and the empirical data developed by USARIEM.

This study had four objectives. The first objective was accomplished with 24 different models found which, in one form or another, represent physiological performance of tasking. The second objective of a useful algorithm has been accomplished. By combining Christensen's nomograph and Borg's perceived energy table a programmer has the tool required to select a set of work rate values to use as input into the soldier status system. The third objective was to assist in the insertion of the formula into the IUSS. This will be accomplished after the review of this methodology and concurrence from the government that this is an accepted direction.

The assumptions stated in Section 1.2 have not changed. Changes to this method, based on empirical data, will be required. As the database of physiological performance grows, this method should be replaced with more robust task data.

The procedure for calculating work rate, in fact, was based on different models and was kept as simple as possible. This allows for ease of use for those unfamiliar with physiological terms and equations and does not overwhelm the programmer with unnecessary information.

The recommendations to be considered are:

Validate the work rate method with data from the Metabolic Task Inventory study.

Implement this method into IUSS and begin collecting field data to populate the database within the soldier system.

Where data can not be obtained in the field, use subject matter experts to rate the tasks using the Energy Expenditure Table and a questionnaire designed to gather the required data.

Questionnaires should be developed which can elicit the data from the SMEs in an effective and efficient manner. The use of the questionnaire data will provide valid data for the IUSS database.

Begin implementation of the next phase of this study:

Develop methods for representing fatigue and other physiological degradation.

Design a set of algorithms representing the mental and physical constructs of physiological, cognitive and psychological inputs to the IUSS.

This document reports research undertaken at the U.S. Army Natick Research, Development and Engineering Center and has been assigned No. NATICK/TR-~~64~~ 026 in the series of reports approved for publication.

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## **APPENDICES**

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**APPENDIX A**  
**Database Descriptions**

## APPENDIX A **Database Descriptions**

**AEROSPACE DATABASE:** Provides references, abstracts and controlled-vocabulary indexing of key scientific and technical documents, as well as books, reports and conferences, covering aerospace research and development in over 40 countries. This database supports basic and applied research in aeronautics, astronautics, and space sciences, as well as technology development and applications complementary and supporting fields, such as chemistry, geosciences, physics, communications and electronics.

**BIOSIS PREVIEWS:** Contains over 8.3 million citations from Biological Abstracts, Biological Abstracts/RRM and BioResearch Index. These publications constitute the major English-language services providing comprehensive worldwide coverage of research in the biological and biomedical sciences.

**DISSERTATION ABSTRACTS ONLINE:** Subject, title and author guide to virtually every American dissertation accepted at an accredited institution since 1861. In addition, citations for thousands of Canadian dissertations and an increasing number of papers accepted abroad are included in the database. All subject areas are included. British and European dissertations are included in the database from January 1988 forward. Also abstracts are included for masters theses from Spring 1988 to the present.

**EiCOMPENDEX\*PLUS:** Version of The Engineering Index, which provides abstracted information from the world's significant literature of engineering and technology. Provides worldwide coverage of approximately 4,500 journals and selected government reports and books. Subjects include: civil, energy, environmental, geological and biological engineering; electrical, electronics, and control engineering; chemical, mining, metals, and fuel engineering; mechanical, automotive, nuclear and aerospace engineering; and computers, robotics and industrial robotics.

**EMBASE (formerly EXCERPTA MEDICA):** One of the leading sources of biomedical literature. It consists of abstracts and citations of over 3,500 biomedical and pharmacological journals published throughout the world.

**ENERGY SCIENCE AND TECHNOLOGY:** Database of the Department of Energy, one of the largest sources of literature references on all aspects of energy and related topics.

**FLUIDEX (FLUID ENGINEERING ABSTRACTS):** Indexing and abstracting literature on every aspect of fluid engineering, from theoretical research to the latest technology and applications. Nearly 1,000 technical journals are indexed as well as books, conference proceedings, standards, some British patents and research reports from relevant institutions worldwide.

**HEALTH PERIODICALS DATABASE:** Provides indexing and full text of journals covering a broad range of health subjects and issues. Subjects covered include pre-natal care, dieting, drug abuse, AIDS, biotechnology, cardiovascular disease, environment, public health, safety, paramedical professions, sports medicine, substance abuse, toxicology and much more. Articles are collected from core health, fitness and nutrition publications.

**IHS INTERNATIONAL STANDARDS AND SPECIFICATIONS:** Contains references to industry standards and military and federal specifications and standards covering all aspects of engineering and

related disciplines. The file includes 90% of the world's most referenced standards from over 70 domestic, foreign and international standardizing bodies.

**INSPEC:** The Database for Physics, Electronics and Computing corresponds to the three Science Abstracts print publications: Physics Abstracts, Electrical and Electronics Abstracts and Computer and Control Abstracts. Approximately 16% of the database's source publications are in languages other than English, but all articles are abstracted and indexed in English.

**INTERNATIONAL PHARMACEUTICAL ABSTRACTS:** Provides information on the development and use of drugs and on professional pharmaceutical practice. The IPA database indexed and abstracted from over 650 pharmaceutical, medical and related journals. The scope of the database ranges from clinical, practical, and theoretical to the economic and scientific aspects of the field.

**MECHANICAL ENGINEERING ABSTRACTS:** Information Service in Mechanical Engineering (ISMEC) indexes significant articles on all aspects of mechanical engineering from approximately 750 journals published throughout the world. Books, reports and conference proceedings are indexed. The principal areas covered are mechanical, nuclear, electrical, electronic, civil, optical, medical, and industrial, mechanics, energy and power, transport and handling and applications of mechanical engineering.

**MEDLINE:** Major source of biomedical literature, corresponds to three print indexes: Index Medicus, Index to Dental Literature and International Nursing Index. MEDLINE covers practically every subject in the broad field of biomedicine, indexing articles from over 3,700 international journals published in the United States and 70 other countries.

**AMERICAN MEDICAL ASSOCIATION JOURNALS ONLINE:** Part of the MEDTEXT database. Full-text articles from 10 medical journals, including JAMA.

**NATIONAL NEWSPAPER INDEX:** Provides indexing of the Christian Science Monitor, New York Times, and The Wall Street Journal. All articles, news reports, editorials, letters to the editor, etc. are included. Also included in the database are three newswires: PR Newswire, Japan Economic Newswire and Reuters Financial Report.

**NEWSEARCH:** Daily index of more than 2,000 news stories, articles and book reviews from over 1,700 of the most important newspapers, magazines and periodicals. Also includes the Area Business Databank (ABD), which contains indexing and abstracts from over 100 local and regional business publications, and the complete text of PR Newswire.

**NTIS:** Provides access to the results of government-sponsored research, development, and engineering, plus an analyses prepared by federal agencies, their contractors or grantees. It is a means through which unclassified, publicly available, unlimited distribution reports are made available for sale from agencies such as NASA, DDC, DOE, HUD, DOT, Department of Commerce and some 600 other agencies. In addition, some state and local government agencies contribute their reports to the database. NTIS also provides access to the results of government-sponsored research and development from countries outside the U.S. Organizations that currently contribute to the NTIS database include: the Japan Ministry of International Trade and Industry (MITI), laboratories administered by the United Kingdom Department of Industry, the German Federal Ministry of Research and Technology (BMFT), the French National Center for Scientific Research (CNRS) and many more.

**PASCAL:** Multidisciplinary database equivalent to the 79 print Pascal journals. Literature from international sources is indexed and abstracted, including journals, doctoral dissertations and masters theses, reports, conference proceedings, and books. Some patents are included in the area of biotechnology. Major subject areas are: life science, biology, medicine, chemistry, pollution, energy, metallurgy, mechanical and civil engineering, transportation, food and agricultural sciences, earth sciences, physics and space sciences and computer science and engineering. The file is bilingual (French and English) and approximately 50% of the records have abstracts.

**SCISEARCH:** Multidisciplinary index to the literature of science and technology. Prepared by the Institute for Scientific Information (ISI), it contains all records published in Science Citation Index (SCI) and additional records from the Current Contents series of publications that are not included in the print version of SCI. Includes 90% of the world's significant scientific and technical literature. SCISEARCH covers every area of pure and applied sciences.

**SPORT:** Bibliographic database, international in scope, covering the practical and research literature for all aspects of sport and physical fitness. The database annually indexes over 1,000 international sports periodicals along with many medical and other related journals in English, French and other languages. Subjects covered include sports medicine, exercise physiology, biomechanics, psychology, training, coaching, physical education, physical fitness, sport for the disabled, facilities, equipment and recreation and leisure.

**STANDARDS AND SPECIFICATIONS:** Provides bibliographic access to all U.S. government and industry standards, specifications and related documents that specify terminology, performance testing, safety, materials, products, or other requirements and characteristics of interest to a particular technology or industry.

**TOXLINE:** Covers adverse effects of chemicals, drugs and physical agents on living systems. About 45% of the approximate 120,000 records added per year are from the TOXBIB subfile, which is derived from MEDLINE. The database is composed of several subfiles, each of which covers a different aspect of toxicology.

**TRADE AND INDUSTRY ASAP:** Provides selective complete text and indexing for over 200 journals chosen from the more than 400 journals covered in TRADE AND INDUSTRY INDEX, plus news releases from PR Newswire. The full text of each article is searchable and complete articles may be retrieved online.

**TRADE AND INDUSTRY INDEX:** Business journals relating to trade, industry and commerce are indexed and selectively abstracted. This database provides current and comprehensive coverage of major trade journals and industry-related periodicals representing all Standard Industrial Classification. Provides indexing and abstracts of over 300 trade and industry journals, as well as a comprehensive but selective coverage of business and trade information from nearly 1,200 additional publications.

**WORLD TRANSLATIONS INDEX:** Unique source for existing translations of literature relating to all fields of science and technology. The database is the machine-readable version of the publication World Translations Index (WTI). WTI contains bibliographic references to both the original and translated documents, reflecting the translation announcements collected by the International Translations Centre (ITC), the Centre National de la Recherche Scientifique et Technique (CNRS/INIST) and various national centers such as the U.S. National Translations Center(NTC).

## **APPENDIX B**

### **Bibliography**

## Appendix B

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## **APPENDIX C**

### **Military Tasks for IUSS**

## Appendix C

### Military Tasks for IUSS

#### Infantry Tasks

- 071-000-0002 Supervise Zeroing of Organic Weapons
- 071-000-0003 Supervise Boresighting of Organic Weapons
- 071-002-0001 Perform Operator Maintenance on a .45 Caliber Pistol
- 071-002-0002 Perform a Function Check on a .45 Caliber Pistol
- 071-002-0005 Operate a .45 Caliber Pistol
- 071-004-0001 Perform Operator Maintenance on an M9 Pistol
- 071-004-0002 Perform a Function Check on an M9 Pistol
- 071-004-0003 Load an M9 Pistol
- 071-004-0003 Operate an M9 Pistol
- 071-004-0004 Unload an M9 Pistol
- 071-004-0005 Correct Malfunctions of an M9 Pistol
- 071-004-0006 Engage Targets With an M9 Pistol
- 071-008-0001 Mount a Night Vision Sight AN/PVS-4 on an M16A1 or M16A2 Rifle
- 071-008-0002 Dismount a Night Vision Sight AN/PVS-4 From an M16A1 or M16A2 Rifle
- 071-010-0001 Zero a Night Vision Sight AN/PVS-4 to an M249 Machine Gun
- 071-010-0002 Mount a Night Vision Sight AN/PVS-4 on an M249 Machine Gun
- 071-010-0003 Dismount a Night Vision Sight AN/PVS-4 From an M249 Machine Gun
- 071-010-0006 Engage Targets with the M249 Machine Gun
- 071-010-0007 Engage Targets with the M249 Machine Gun Using Night Vision Sight AN/PVS-4
- 071-020-0001 Mount a Night Vision Sight AN/PVS-4 on an M60 Machine Gun
- 071-020-0002 Dismount a Night Vision Sight AN/PVS-4 From an M60 Machine Gun
- 071-020-0006 Mount an M60 Machine Gun on an M122 Tripod
- 071-020-0007 Dismount an M60 Machine Gun from an M122 Tripod
- 071-020-0008 Mount a Night Vision Sight AN/PVS-2 on an M60 Machine Gun
- 071-020-0009 Dismount a Night Vision Sight AN/PVS-2 from an M60 Machine Gun
- 071-022-0001 Maintain a .50 Caliber M2 Machine Gun
- 071-022-0002 Perform a Function Check on a .50 Caliber M2 Machine Gun
- 071-022-0003 Operate a .50 Caliber M2 Machine Gun
- 071-022-0003 Load a .50 Caliber M2 Machine Gun
- 071-022-0004 Unload a .50 Caliber M2 Machine Gun
- 071-022-0005 Correct Malfunctions of the .50 Caliber M2 Machine Gun
- 071-022-0006 Mount a Night Vision Sight AN/TVS-2 on a .50 Caliber M2 Machine Gun
- 071-022-0007 Dismount a Night Vision Sight AN/TVS-2 from a .50 Caliber M2 Machine Gun
- 071-022-0008 Mount a Night Vision Sight AN/TVS-5 on a .50 Caliber M2 Machine Gun
- 071-022-0009 Dismount a Night Vision Sight AN/TVS-5 from a .50 Caliber M2 Machine Gun
- 071-022-0010 Mount a .50 Caliber M2 Machine Gun on an M3 Tripod
- 071-022-0011 Dismount a .50 Caliber M2 Machine Gun from an M3 Tripod
- 071-022-0012 Mount a .50 Caliber M2 Machine Gun on a Vehicle
- 071-022-0013 Dismount a .50 Caliber M2 Machine Gun from a Vehicle
- 071-022-0014 Construct a Fighting Position for a .50 Caliber M2 Machine Gun
- 071-022-0015 Prepare a Range Card for a .50 Caliber M2 Machine Gun
- 071-024-0001 Load the 25-mm Ammunition Ready Box (HE/HEI-T) on a BFV

- 071-024-0002 Load the 25-mm Ammunition Ready Box (APDS/APDS-T) on a BFV  
 071-024-0003 Unload the 25-mm Ammunition Ready Box (HEI-T) on a BFV  
 071-024-0004 Unload the 25-mm Ammunition Ready Box (APDS-T) on a BFV  
 071-024-0005 Maintain the 25-mm Automatic Gun on a BFV  
 071-024-0006 Perform a Function Check on the 25-mm Automatic Gun on a BFV  
 071-024-0007 Load the 25-mm Automatic Gun on a BFV  
 071-024-0008 Unload the 25-mm Automatic Gun on a BFV  
 071-024-0009 Zero the 25-mm Automatic Gun on a BFV  
 071-026-0001 Load the M240C Coaxial Machine Gun on a BFV  
 071-026-0002 Unload the M240C Coaxial Machine Gun on a BFV  
 071-026-0003 Zero the M240C Coaxial Machine Gun on a BFV  
 071-028-0001 Maintain an M231 Firing Port Weapon  
 071-028-0002 Perform a Function Check on an M231 Firing Port Weapon  
 071-028-0003 Install an M231 Firing Port Weapon on an M2 BFV  
 071-028-0004 Remove an M231 Firing Port Weapon from a M2 BFV  
 071-028-0005 Load an M231 Firing Port Weapon  
 071-028-0006 Unload an M231 Firing Port Weapon  
 071-030-0001 Maintain an MK19 Machine Gun  
 071-030-0002 Prepare a Range Card for an MK19 Machine Gun  
 071-030-0003 Zero an MK19 Machine Gun  
 071-030-0004 Engage Targets with an MK19 Machine Gun  
 071-030-0005 Load an MK19 Machine Gun  
 071-030-0006 Unload an MK19 Machine Gun  
 071-030-0007 Perform a Function Check on an MK19 Machine Gun  
 071-030-0008 Correct Malfunctions of an MK19 Machine Gun  
 071-030-0009 Mount an MK19 Machine Gun on a Vehicle  
 071-030-0010 Dismount an MK19 Machine Gun from a Vehicle  
 071-030-0011 Mount an MK19 Machine Gun on an M3 Tripod  
 071-030-0012 Dismount an MK19 Machine Gun from an M3 Tripod  
 071-030-0013 Construct a Fighting Position for an MK19 Machine Gun  
 071-030-0015 Select a Fighting Position for an MK19 Machine Gun  
 071-032-0001 Mount a Night Vision Sight AN/PVS-4 on an M203 Grenade Launcher  
 071-032-0002 Dismount a Night Vision Sight AN/PVS-4 from an M203 Grenade Launcher  
 071-032-0006 Construct Field Expedient Firing Aids for an M203 Grenade Launcher  
 071-034-0001 Load an M243 or M259 Smoke Grenade Launcher  
 071-034-0002 Unload an M243 or M259 Smoke Grenade Launcher  
 071-034-0003 Perform Misfire Procedures on an M243 or M259 Smoke Grenade Launcher  
 071-034-0004 Fire an M243 or M259 Smoke Grenade Launcher  
 071-034-0005 Load the M257 Smoke Grenade Launcher on a BFV  
 071-034-0006 Unload the M257 Smoke Grenade Launcher on a BFV  
 071-034-0007 Maintain an M243 or M259 Smoke Grenade Launcher  
 071-052-0001 Maintain an M47 Medium Antitank Weapon  
 071-052-0002 Maintain a Night Vision Sight AN/PVS-5  
 071-052-0003 Construct a Fighting Position for an M47 Medium Antitank Weapon  
 071-052-0004 Restore an M47 Medium Antitank Weapon to Carrying Configuration  
 071-052-0005 Operate a Night Vision Sight AN/TAS-5  
 071-052-0006 Engage Targets With an M47 Medium Antitank Weapon  
 071-054-0001 Prepare an M136 Launcher for Firing  
 071-054-0002 Restore an M136 Launcher to Carrying Configuration  
 071-054-0003 Perform Misfire Procedures on an M136 Launcher

- 071-054-0004 Engage Targets with an M136 Launcher  
 071-056-0001 Load the TOW Launcher on a BFV  
 071-056-0002 Unload the TOW Launcher on a BFV  
 071-056-0003 Operate the TOW Launcher on a BFV  
 071-058-0001 Maintain an M67 Recoilless Rifle  
 071-058-0002 Perform a Function Check on an M67 Recoilless Rifle  
 071-058-0003 Load an M67 Recoilless Rifle  
 071-058-0004 Unload an M67 Recoilless Rifle  
 071-058-0005 Construct a Fighting Position for an M67 Recoilless Rifle  
 071-070-0001 Maintain an M202A1 Multishot Rocket Launcher  
 071-070-0002 Perform a Function Check on an M202A1 Multishot Rocket Launcher  
 071-070-0003 Load an M202A1 Multishot Rocket Launcher  
 071-070-0004 Unload an M202A1 Multishot Rocket Launcher  
 071-070-0005 Perform Misfire Procedures on an M202A1 Multishot Rocket Launcher  
 071-070-0006 Prepare an M202A1 Multishot Rocket Launcher for Firing  
 071-070-0007 Restore an M202A1 Multishot Rocket Launcher to Carrying Configuration  
 071-070-0008 Engage Targets with an M202A1 Multishot Rocket Launcher  
 071-098-0001 Recover a Mechanical Ambush  
 071-098-0002 Install a Mechanical Ambush  
 071-098-0004 Conduct the Breach of a Minefield  
 071-121-3009 Control Movement Techniques  
 071-200-0001 Supervise Towing of a Vehicle  
 071-200-0002 Tow a Tracked Vehicle  
 071-212-0001 Maintain the Air Cleaner System on an M113 Series Vehicle  
 071-212-0002 Maintain the Electrical System on an M113 Series Vehicle  
 071-212-0003 Maintain the Brake System on an M113 Series Vehicle  
 071-212-0004 Maintain the Cooling System on an M113 Series Vehicle  
 071-212-0005 Maintain the Engine on an M113 Series Vehicle  
 071-212-0006 Maintain the Fuel System on an M113 Series Vehicle  
 071-212-0007 Maintain the Steering System on an M113 Series Vehicle  
 071-212-0008 Maintain the Transmission System on an M113 Series Vehicle  
 071-212-0009 Maintain the Heating System on an M113 Series Vehicle  
 071-212-0010 Maintain the Fire Suppression System on an M113 Series Vehicle  
 071-212-0011 Maintain the Exhaust System on an M113 Series Vehicle  
 071-212-0012 Maintain the Bilge System on an M113 Series Vehicle  
 071-212-0013 Maintain the Hydraulic System on an M113 Series Vehicle  
 071-212-0014 Maintain the Track and Suspension System on an M113 Series Vehicle  
 071-212-0015 Maintain the Hull on an M113 Series Vehicle  
 071-212-0016 Prepare an M113 Series Vehicle for Water Operations  
 071-212-0017 Maintain and Operate the NBC System on an M113 Series Vehicle  
 071-212-0019 Operate the M19 Periscope on an M113 Series Vehicle  
 071-212-0020 Start an M113 Series Vehicle Using Auxiliary Power  
 071-212-0021 Drive an M113 Series Vehicle  
 071-216-0001 Maintain the TOW System on a BFV  
 071-216-0002 Maintain the Smoke Generating System on a BFV  
 071-216-0003 Maintain the Electrical System on a BFV  
 071-216-0004 Maintain the Track and Suspension System on a BFV  
 071-216-0005 Maintain the Fire Suppression System on a BFV  
 071-216-0007 Maintain the Hull on a BFV  
 071-216-0008 Maintain the NBC System on a BFV

- 071-216-0009      Maintain the Turret on a BFV  
 071-216-0010      Maintain the Exhaust System on a BFV  
 071-216-0011      Maintain the Fuel System on a BFV  
 071-216-0012      Maintain the Cooling System on a BFV  
 071-216-0013      Maintain the Heating System on a BFV  
 071-216-0014      Maintain the Hydraulic System on a BFV  
 071-216-0016      Maintain the Engine on a BFV  
 071-216-0017      Maintain the Communications System on a BFV  
 071-216-0019      Maintain the Bilge System on a BFV  
 071-311-2001      Perform Operator Maintenance on an M16A1 Rifle, Magazine, and Ammunition  
 071-311-2003      Load, Reduce a Stoppage, and Clear an M16A1 Rifle  
 071-311-2004      Zero an M16A1 Rifle  
 071-311-2006      Construct Field Expedient Firing Aids for an M16A1 or M16A2 Rifle  
 071-311-2006      Use Limited Visibility Firing Techniques with an M16A1 Rifle  
 071-311-2007      Engage Targets With an M16A1 or M16A2 Rifle  
 071-311-2025      Maintain an M16A1 or M16A2 Rifle  
 071-311-2026      Perform a Function Check on an M16A1 or M16A2 Rifle  
 071-311-2027      Load an M16A1 or M16A2 Rifle  
 071-311-2028      Unload an M16A1 or M16A2 Rifle  
 071-311-2029      Correct Malfunctions of an M16A1 or M16A2 Rifle  
 071-311-2030      Zero an M16A2 Rifle  
 071-311-2101      Perform Operator Maintenance on an M203 Grenade Launcher and Ammunition  
 071-311-2102      Load, Unload, and Clear an M203 Grenade Launcher  
 071-311-2103      Zero an M203 Grenade Launcher  
 071-311-2104      Engage Targets With an M203 Grenade Launcher and Apply Immediate Action to Reduce a Stoppage  
 071-311-2105      Use Limited Visibility Firing Techniques with an M203 Grenade Launcher  
 071-311-2125      Maintain an M203 Grenade Launcher  
 071-311-2126      Perform a Function Check on an M203 Grenade Launcher  
 071-311-2127      Load an M203 Grenade Launcher  
 071-311-2128      Unload an M203 Grenade Launcher  
 071-311-2129      Correct Malfunctions of an M203 Grenade Launcher  
 071-311-2130      Engage Targets With an M203 Grenade Launcher  
 071-311-3001      Perform Operator Maintenance on a .45 Caliber Pistol  
 071-311-3002      Engage Targets With a .45 Caliber Pistol  
 071-311-6001      Perform Operator Maintenance on M231 Firing Port Weapon  
 071-311-6002      Install/Remove M231 Firing Port Weapon  
 071-311-6003      Load/Unload and Clear M231 Firing Port Weapon  
 071-311-6004      Perform Misfire Procedures on M231 Firing Port Weapon  
 071-311-6005      Engage Targets with M231 Firing Port Weapon  
 071-312-2322      Mount/Dismount the M60 Machine Gun on the M4 Pedestal Mount  
 071-312-3001      Load, Reduce a Stoppage, and Clear an M60 Machine Gun  
 071-312-3002      Fire an M60 Machine Gun  
 071-312-3003      Lay an M60 Machine Gun Using Field Expedients  
 071-312-3004      Construct a Fighting Position for an M60 Machine Gun  
 071-312-3005      Perform Operator Maintenance on an M60 Machine Gun and Ammunition  
 071-312-3006      Field Zero an M60 Machine Gun  
 071-312-3007      Prepare a Range Card For an M60 Machine Gun  
 071-312-3009      Zero the M60 Machine Gun on a 10-meter Range  
 071-312-3025      Maintain an M60 Machine Gun

- 071-312-3026 Perform a Function Check on an M60 Machine Gun  
 071-312-3027 Load an M60 Machine Gun  
 071-312-3028 Unload an M60 Machine Gun  
 071-312-3029 Correct Malfunctions of an M60 Machine Gun  
 071-312-3030 Zero an M60 Machine Gun  
 071-312-3031 Engage Targets With an M60 Machine Gun  
 071-312-4001 Perform Operator Maintenance on an M249 Machine Gun and Ammunition  
 071-312-4002 Load, Reduce a Stoppage, and Clear an M249 Machine Gun  
 071-312-4003 Field Zero an M249 Machine Gun  
 071-312-4004 Lay an M249 Machine Gun Using Field Expedients  
 071-312-4025 Perform Operator Maintenance on an M249 Machine Gun  
 071-312-4027 Operate an M249 Machine Gun  
 071-312-4030 Zero an M249 Machine Gun  
 071-312-4032 Prepare a Range Card for an M249 Machine Gun  
 071-313-3451 Perform Operator Maintenance on a .50 Caliber M2 Machine Gun  
 071-313-3452 Zero a .50 Caliber M2 Machine Gun  
 071-313-3453 Prepare a Range Card for a .50 Caliber M2 Machine Gun  
 071-313-3454 Engage Targets with a Caliber .50 M2 Machine Gun  
 071-313-3455 Set Headspace and Timing on a .50 Caliber M2 Machine Gun  
 071-313-3462 Mount/Dismount a .50 Caliber M2 Machine Gun on a Tracked Vehicle  
 071-313-4003 Load, Unload & Clear an M240C Machine Gun on a BFV  
 071-313-4004 Boresight the M240C Coaxial Machine Gun on a BFV  
 071-313-4006 Correct Malfunctions of the M240C Coaxial Machine Gun on a BFV  
 071-313-4007 Engage Targets With the M240C Coaxial Machine Gun Using the ISU on a BFV  
 071-313-4008 Engage Targets With the M240C Coaxial Machine Gun Using the Auxiliary Sight on a BFV  
 071-314-0001 Boresight the Auxiliary Sight on the BFV  
 071-314-0002 Load/Unload 25-mm Ready Boxes on an M2/M3 Bradley  
 071-314-0003 Perform Operator's Maintenance on a 25-mm Automatic Gun  
 071-314-0006 Load, Unload & Clear 25-mm Automatic Gun on a BFV  
 071-314-0008 Boresight the 25-mm Automatic Gun on a BFV  
 071-314-0009 Zero 25-mm Automatic Gun and M240C to the ISU  
 071-314-0011 Perform Misfire Procedures on the 25-mm Automatic Gun on a BFV  
 071-314-0012 Engage Targets With the 25-mm Automatic Gun Using the ISU on a BFV  
 071-314-0013 Engage Targets With the 25-mm Automatic Gun Using the Auxiliary Sight on BFV  
 071-314-0017 Issue a Fire Command for the M2 BFV  
 071-314-2003 Prepare a Range Card For an M3 Bradley  
 071-315-0003 Operate a Night Vision Sight AN/PVS-4  
 071-315-0008 Engage Targets With an M60 Machine Gun Using a Night Vision Sight AN/PVS-4  
 071-315-0030 Operate the Night Vision Goggles AN/PVS-5  
 071-315-0031 Maintain the Night Vision Goggles AN/PVS-5  
 071-315-0039 Operate M18 Infrared Binoculars  
 071-315-0056 Engage Targets With a Caliber .50 M2 HB Machine Gun Mounted With an AN/TVS-5 Night Sight  
 071-315-0090 Maintain a Thermal Viewer AN/PAS-7  
 071-315-0091 Operate a Thermal Viewer AN/PAS-7  
 071-315-2301 Perform Operator's Maintenance on an AN/PVS-2  
 071-315-2302 Conduct Surveillance Using AN/PVS-2  
 071-315-2303 Mount and Dismount AN/PVS-2 on an M16A1 Rifle

071-315-2304	Zero an AN/PVS-2 to an M16A1 Rifle
071-315-2305	Engage Targets with M16A1 Rifle Using AN/PVS-2
071-315-2306	Mount and Dismount a Night Vision Sight AN/PVS-4 to an M16A1 Rifle
071-315-2307	Zero a Night Vision Sight AN/PVS-4 to an M16A1 or M16A2 Rifle
071-315-2308	Engage Targets With an M16A1 or M16A2 Rifle Using a Night Vision Sight AN/PVS-4
071-315-2310	Mount and Dismount an AN/PVS-2 on an M60 Machine Gun
071-315-2311	Zero an AN/PVS-2 to an M60 Machine Gun
071-315-2312	Mount and Dismount a Night Vision Sight AN/PVS-4 to an M60 Machine Gun
071-315-2313	Zero a Night Vision Sight AN/PVS-4 to an M60 Machine Gun
071-315-2314	Mount and Dismount a Night Vision Sight AN/TVS-2 to a .50 Caliber M2 Machine Gun
071-315-2315	Zero a Night Vision Sight AN/TVS-2 to a .50 Caliber M2 Machine Gun
071-315-2316	Mount and Dismount a Night Vision Sight AN/TVS-5 to a .50 Caliber M2 Machine Gun
071-315-2317	Zero a Night Vision Sight AN/TVS-5 to a .50 Caliber M2 Machine Gun
071-315-2350	Mount and Dismount a Night Vision Sight AN/PVS-4 to an M203 Grenade Launcher
071-315-2351	Zero a Night Vision Sight AN/PVS-4 to an M203 Grenade Launcher
071-315-2352	Engage Targets with an M203 Grenade Launcher Using a Night Vision Sight AN/PVS-4
071-316-2500	Assemble a TOW Launcher
071-316-2501	Perform Operator Maintenance on a TOW Launcher
071-316-2502	Conduct a System Self-Test and Preoperation Inspection of a TOW Launcher and Encased Missile
071-316-2503	Load, Arm, and Unload an Encased TOW Missile
071-316-2504	Perform Immediate Action For a TOW Missile
071-316-2505	Determine If a Target Can Be Engaged By a TOW Missile
071-316-2508	Conduct Dismount and Remount TOW Operations
071-316-2519	Engage a Target With a TOW
071-316-2523	Install TOW Components and Encased Missiles on an ITV (M901)
071-316-2524	Erect Launcher From a Stow Position
071-316-2526	Stow a Launcher on an ITV (M901)
071-316-2527	Collimate and Operate an AN/TAS-4 Night Sight
071-316-2529	Prepare an ITV (M901) Dual Launcher For Loading
071-316-2530	Load a Dual Launcher With Encased Missile(s) and Return to Stow Position
071-316-2531	Engage a Target With an ITV (M901) Dual Launcher
071-316-2532	Perform Immediate Action For an ITV (M901) Dual Launcher Misfire
071-316-2534	Operate M243 Smoke Grenade Launcher on an ITV (M901)
071-316-2535	Conduct Preoperational Checks on an ITV (M901) (Turret)
071-316-2536	Operate the ITV (M901) Dual Launcher Using Emergency Action Procedures
071-316-2540	Mount, Stow, and Dismount an M60 Machine Gun on an ITV (M901)
071-316-2550	Occupy a TOW Firing Position
071-316-2903	Place an AN/TVS-4 Night Observation Device Into Operation
071-316-3002	Perform Misfire Procedures on the TOW System on a BFV
071-316-3005	Boresight a TOW Launcher on a BFV
071-316-3006	Engage Targets With the TOW System on a BFV
071-316-3009	Load/Unload a TOW Launcher on an M2/M3 Bradley
071-316-3015	Remove a Misfired TOW Missile From the TOW Launcher on a BFV
071-316-4000	Assemble a TOW 2 Launcher

- 071-316-4001      Conduct a System Check-Out and Preoperation Inspection of a TOW 2 Launcher and Encased Missile
- 071-316-4002      Perform Operator Maintenance on a TOW 2 Launcher
- 071-316-4003      Perform Immediate Action For a TOW 2 Misfire
- 071-316-4005      Engage a Target With a TOW 2
- 071-316-4050      Conduct Preoperationa Check on an ITV (M901A1) (Turret)(TOW 2)
- 071-316-4051      Conduct a System Check-Out Procedure on an ITV TOW 2 (M901A1)
- 071-316-4053      Enage a Target With an ITV TOW 2 (M901A1) Dual Launcher
- 071-316-4055      Conduct Dismount and Remount TOW 2 Operations (M901A1)
- 071-317-0000      Prepare an Antiarmor Range Card
- 071-317-3301      Conduct a Preoperation Inspection and Perform Operator Maintenance on a Dragon Tracker and Round
- 071-317-3302      Prepare an M47 Medium Antitank Weapon For Firing
- 071-317-3303      Determine if a Target is Engageable by a Dragon
- 071-317-3304      Demonstrate Correct Dragon Firing Position
- 071-317-3306      Perform Misfire Procedures on an M47 Medium Antitank Weapon
- 071-317-3307      Construct a Fighting Position (Dragon/90-mm RCLR)
- 071-317-3324      Select a Fighting Position for an M47 Medium Antitank Weapon
- 071-318-2201      Prepare an M72A2 Law For Firing
- 071-318-2202      Engage Targets With an M72A2 Law
- 071-318-2203      Apply Immediate Action to Correct a Malfunction on an M72A2 Law
- 071-318-2205      Control the Employment of a Squad's M72A2 Laws
- 071-318-2210      Prepare an M72A2 Law For Firing
- 071-318-2211      Restore an M72A2 Law to Carrying Configuration
- 071-319-3151      Perform Operator Maintenance on an M67 Recoilless Rifle
- 071-319-3152      Boresight an M67 Recoilless Rifle
- 071-319-3153      Load, Unload, and Clear an M67 Recoilless Rifle
- 071-319-3155      Engage Targets with an M67 Recoilless Rifle
- 071-324-1008      Perform PMCS on the Hull of an M2/3 Bradley
- 071-324-2003      Prepare a Range Card for a M2 BFV
- 071-324-3052      Direct Fire and Maneuver of a Dismount Team Against an Enemy Position
- 071-324-4002      Load, Unload, & Stow Smoke Grenades for the M257 Smoke Grenade Launcher  
on an M2/M3 Bradley
- 071-324-4003      Fire the M257 Smoke Grenade Launcher on a BFV
- 071-324-4004      Perform Misfire Procedures on the M257 Smoke Grenade Launcher on a BFV
- 071-324-6001      Drive a BFV
- 071-324-6003      Shut Down the Driver's Station on an M2/M3 Bradley to include Crew Area
- 071-324-6004      Operate the Turret on a BFV
- 071-324-6004      Shut Down the Turret on a BFV
- 071-324-6007      Break/Join Track on an M2/M3 Bradley
- 071-324-6019      Operate an M2/M3 Bradley in Water
- 071-324-6021      Tow/Tow Start an M2/M3 Bradley
- 071-324-6022      Extinguish a Fire on a BFV
- 071-324-6025      Start a BFV Using Auxiliary Power
- 071-324-6026      Operate the NBC System on an M2A1/M3A1 BFV
- 071-324-6031      Start/Stop the Engine on an M2/M3 Bradley
- 071-324-6033      Drive an M2/M3 Bradley Using Night Vision Equipment
- 071-325-4401      Perform Safety Checks on Hand Grenades
- 071-325-4402      Engage Enemy Targets With Hand Grenades
- 071-325-4405      Identify and Employ Hand Grenades

071-325-4406	Install/Recover a Mechanical Ambush
071-325-4407	Employ Hand Grenades
071-325-4412	Install and Fire/Recover an M18A1 Claymore Mine
071-325-4413	Install an M18A1 Claymore Mine with Trip Wires
071-325-4414	Disarm an M18A1 Claymore Mine with Trip Wires
071-325-4425	Employ an M18A1 Claymore Mine
071-325-4426	Recover an M18A1 Claymore Mine
071-325-4450	Perform Self-Extraction from a Minefield and Probe for Mines
071-326-0500	Move a Casualty from the Immediate Battle Area
071-326-0501	Move As a Member of a Fire Team
071-326-0502	Move Under Direct Fire
071-326-0503	Move Over, Through, or Around Obstacles
071-326-0510	React to Indirect Fire
071-326-0511	React to Flares
071-326-0512	Estimate Range
071-326-0513	Select Temporary Fighting Positions
071-326-0515	Select a Movement Route Using a Map
071-326-0520	Establish a Hot Loop with TA-1/PT Telephone
071-326-0541	Perform Movement Techniques During Military Operations on Urbanized Terrain
071-326-0542	Enter a Building During MOUT
071-326-0543	Organize a Squad for an Attack on a Building
071-326-0547	Organize a Platoon for an Attack on a Building
071-326-0550	Prepare Positions for Individual and Crew Served Weapons During MOUT
071-326-0551	Prepare Building(s) for a Platoon Defensive Position
071-326-0556	Clear a Building
071-326-0557	Select Hasty Firing Positions During MOUT
071-326-0572	Conduct Defensive MOUT Operations with a M2 BFV Platoon
071-326-0573	Control Movement Through Urban Terrain with a M2 BFV Platoon
071-326-0600	Use Visual Signals to Control Movement (Dismounted)
071-326-0608	Use Visual Signalling Techniques While Mounted
071-326-1001	Supervise the Construction and Negotiation of a Slack-Rope Retrievable Bridge (One-Rope)
071-326-1026	Rappel From a Hovering UH-1 Helicopter
071-326-1028	Rappel From a Hovering UH-60 Helicopter
071-326-3000	Supervise Combat Loading of Personnel and Equipment on a Vehicle
071-326-3001	Direct a Driver Over a Terrain Route
071-326-3002	React to Indirect Fire While Mounted
071-326-3004	Control Occupation of a Bounding Position
071-326-3006	Conduct the Maneuver of a Mechanized (M113) Squad
071-326-3007	Determine Movement Techniques for a Mechanized Infantry Platoon
071-326-3008	Control Platoon APCs in the Defense
071-326-3011	Drive a Tracked Vehicle Using Terrain for Cover and Concealment
071-326-3012	React to Enemy Direct Fire while Mounted on an M2 BFV
071-326-3013	Conduct Tactical Road March
071-326-3048	Conduct an Ambush
071-326-3049	Conduct Troop Leading Procedures For an Operation
071-326-3054	Direct Dismount Team Fires in the Defense
071-326-3055	Ensure OPSEC of a BFV Squad
071-326-3056	Direct Dismount of a M2 BFV
071-326-3057	Supervise Combat Loading of M2 BFV Personnel and Equipment

071-326-3060	Consolidate and Reorganize a BFV Squad
071-326-3604	Conduct a Disengagement with a M2 BFV Platoon
071-326-5501	Control Rate and Distribution of Fire
071-326-5502	Issue a Fragmentary Order
071-326-5503	Issue a Warning Order
071-326-5505	Prepare and Issue an Oral Operation Order
071-326-5509	Consolidate and Reorganize Squad-Sized Element Following Enemy Contact (Offense)
071-326-5510	Consolidate and Reorganize Squad-Sized Element Following Enemy Contact (Defense)
071-326-5511	Consolidate and Reorganize Platoon Sized Element Following Enemy Contact (Defense)
071-326-5512	Consolidate and Reorganize Platoon Sized Element Following Enemy Contact (Offense)
071-326-5515	Organize Platoon for Night Defense
071-326-5605	Control Fire Team Movement
071-326-5606	Select Overwatch Positions
071-326-5610	Implement Infantry Squad Movement Techniques When Not In Contact With the Enemy
071-326-5611	Direct the Fire and Maneuver of an Infantry Squad Against an Enemy Position
071-326-5625	Prepare and Issue an Oral Platoon Operation Order (OPORD) for an Offensive Mission
071-326-5626	Prepare and Issue an Oral Operation Order (OPORD)
071-326-5630	Conduct Movement Techniques By a Platoon
071-326-5635	Direct Fire and Maneuver of a Platoon Against an Enemy Position
071-326-5701	Supervise the Preparation of a Squad-Size Element's Defensive Position
071-326-5703	Construct an Individual Fighting Position
071-326-5704	Supervise Construction of a Fighting Position
071-326-5705	Establish an Observation Post
071-326-5710	Designate Fighting Positions for Squad Members (Less Crew-Served Weapons)
071-326-5711	Designate Alternate and Supplementary Fighting Positions for Squad Members
071-326-5720	Prepare a Squad-Sized Element's Defensive Sector Sketch
071-326-5725	Direct Squad-Sized Element's Fire in the Defense
071-326-5750	Prepare and Issue an Oral Platoon Operation Order for a Defensive Mission
071-326-5761	Designate Primary, Alternate, and Supplementary Fighting Positions For Key Weapons
071-326-5770	Prepare a Platoon Sector Sketch
071-326-5775	Coordinate with Adjacent Platoon-Sized Elements
071-326-5780	Direct Platoon-Sized Elements Fires in the Defense
071-326-5801	Organize an Antiarmor Ambush
071-326-5802	Conduct an Antiarmor Ambush
071-326-5803	Organize an Antiarmor Ambush with an M2 BFV Squad
071-326-5804	Conduct an Antiarmor Ambush with a M2 BFV Squad
071-326-5805	Plan and Conduct a Route Reconnaissance
071-326-5806	Plan and Conduct an Area Reconnaissance
071-326-5807	Plan and Conduct a Screening Mission
071-326-5808	Plan and Conduct a Zone Reconnaissance
071-326-5811	Conduct a Passage of Lines
071-326-5832	Conduct a Disengagement of a Platoon While Under Enemy Pressure
071-326-5832	Plan a Withdrawal Under Enemy Pressure

071-326-5833	Plan a Withdrawal Not Under Enemy Pressure
071-326-5902	Prepare an M2 BFV Squad Defensive Position
071-326-5904	Prepare an M2 BFV Platoon Defensive Position
071-326-5905	Direct M2 BFV Platoon Fires in the Defense
071-326-5907	Ensure OPSEC of a BFV Platoon
071-326-5908	Employ an M2 BFV Platoon on BP
071-326-5910	Control Dismounted BFV Platoon Formations
071-326-5911	Control Mounted BFV Platoon Formations
071-326-5912	Direct the Fire and Maneuver of a BFV Platoon
071-326-5913	Employ an M2 BFV Platoon in the Aerial Defense Role
071-326-5914	Consolidate and Reorganize a BFV Platoon
071-326-5915	Plan a Movement to Contact with the M2 BFV Platoon
071-326-5917	Conduct a Mounted Assault with a M2 BFV Platoon
071-326-5918	Conduct a Dismounted Assault with a M2 BFV Platoon
071-326-5920	Control a Dismount Team Movement
071-326-5921	Move as a Member of a Dismount Team
071-328-5301	Inspect Personnel/Equipment
071-328-5302	Supervise Maintenance on Individual and TOE Equipment
071-328-5303	Practice Preventive Medicine
071-329-1000	Identify Topographic Symbols, Colors, and Use Marginal Information
071-329-1001	Identify Terrain Features on a Map
071-329-1002	Determine the Grid Coordinates of a Point on a Military Map Using the Military Grid Reference System
071-329-1003	Determine a Magnetic Azimuth Using a Compass
071-329-1004	Determine the Elevation of a Point on the Ground Using a Map
071-329-1005	Determine a Location on the Ground By Terrain Association
071-329-1006	Navigate From One Point on the Ground to Another While Dismounted
071-329-1007	Determine Distance While Moving Between Two Points on the Ground
071-329-1008	Measure Distance on a Map
071-329-1009	Convert Azimuths (Magnetic or Grid)
071-329-1011	Orient a Map Using a Lensatic Compass
071-329-1012	Orient a Map to the Ground By Map-Terrain Association
071-329-1014	Locate an Unknown Point on a Map or on the Ground By Intersection
071-329-1015	Locate an Unknown Point on a Map or on the Ground By Resection
071-329-1018	Determine Direction Using Field Expedient Methods
071-329-1019	Use a Map Overlay
071-329-1021	Determine a Target by Grid Coordinates
071-329-1030	Navigate From One Point on the Ground to Another While Mounted
071-329-1031	Determine Azimuths Using a Protractor and Compute Back Azimuths
071-330-3009	Perform PMCS on the Turret of an M2/M2A1, M3/M3A1 Bradley
071-331-0001	Move As a Member of a Patrol
071-331-0002	Conduct a Local Security Patrol
071-331-0003	Plan a Patrol
071-331-0011	Prepare Individual Equipment For Patrol
071-331-0012	Select, Occupy, and Operate a Patrol Base
071-331-0013	Lead a Reconnaissance Patrol
071-331-0014	Lead a Raid
071-331-0015	Lead an Ambush
071-331-0571	Secure a Building with a M2 BFV Squad
071-331-0801	Use Challenge and Password

071-331-0802	Process Enemy Personnel and Equipment
071-331-0803	Collect/Report Information (SALUTE)
071-331-0804	Conduct Day and Night Surveillance Without the Aid of Electronic Devices
071-331-0808	Identify Threat Weapons and Equipment
071-331-0809	Emplace/Recover Field Expedient Warning Devices
071-331-0810	Emplace/Recover Pyrotechnic Early Warning Devices
071-331-0815	Practice Noise, Light, and Litter Discipline
071-331-0820	Analyze Terrain Using the Five Military Aspects of Terrain
071-331-0852	Clear a Field of Fire
071-331-1000	Prepare the Platoon Early Warning System AN/TRS-2 for Operation
071-331-1001	Perfom Pre-Mission Checks on the Platoon Early Warning System AN/TRS-2
071-331-1002	Monitor the Platoon Early Warning System AN/TRS-2
071-331-1003	Installation Planning and Installation of Platoon Early Warning System AN/TRS-2
071-332-5000	Prepare an Operations Overlay
071-332-5001	Prepare, Assemble, and Distribute an Operation Plan/Operation Order/Annex
071-332-5002	Prepare a Fragmentary Order
071-332-5004	Prepare a Battalion Warning Order
071-332-5020	Post an S3 Workbook
071-332-5021	Prepare/Update Enemy/Friendly Situation Map
071-332-5022	Prepare Situation Report (SITREP)
071-332-5030	Prepare Road Movement Graph
071-332-5031	Prepare a Road Movement Table
071-332-5034	Extract Information from a Route Reconnaissance Report
071-332-5036	Prepare Strip Map
071-332-5041	Request Preplanned Close Air Support
071-332-5050	Monitor Operations/Movements of Subordinate Units
071-332-5051	Post a Daily Staff Journal
071-332-5052	Supervise Establishment/Displacement of Tactical Operations Center (TOC)
071-333-6500	Drive a Tracked Vehicle (M113A1 or M901)
071-333-6503	Operate Light Controls and M19 Infrared Periscope on a Tracked Vehicle
071-333-6508	Perform Operator's Maintenance on a Tracked Vehicle
071-333-6512	Negotiate Obstacles in an M113A1
071-333-6515	Remove/Install Track Shoe(s) on a Tracked Vehicle
071-333-6516	Stop the Engine of an M113A1
071-333-6517	Start the Engine of an M113A1
071-333-6518	Troubleshoot an M113A1
071-333-6519	Extinguish a Fire on a Tracked Vehicle (M113A1 or M901)
071-333-6523	Self-Recover an M113A1
071-333-6550	Escape From a Tracked Vehicle
071-334-4001	Guide a Helicopter to a Landing Point
071-334-4002	Establish a Helicopter Landing Point
071-400-0001	Adjust Aerial Fire Support
071-400-0003	Prepare Personnel and Equipment for Air Assault
071-410-0001	Perform Self-Extraction from a Minefield
071-410-0002	React to Direct Fire While Mounted
071-410-0007	Prepare an M2 BFV Rifle Team Sector Sketch
071-410-0008	Prepare a BFV for Fording
071-410-0009	Supervise Preparation of a BFV for Water Operations
071-410-0010	Conduct a Leader's Reconnaissance
071-410-0011	Conduct a Tactical Road March

071-410-0012	Supervise Occupation of an Assembly Area
071-410-0013	Prepare a Situation Report
071-410-0015	Direct Dismount from an M113 Vehicle
071-410-0016	Conduct Occupation of an Overwatch Position
071-410-0019	Control Organic Fires
071-410-0020	Plan for Use of Supporting Fires
071-420-0001	Consolidate a Platoon Following Enemy Contact While In the Offense
071-420-0002	Reorganize a Platoon Following Enemy Contact While In the Offense
071-420-0003	Consolidate a Squad Following Enemy Contact While In the Offense
071-420-0004	Reorganize a Squad Following Enemy Contact While In the Defense
071-420-0005	Conduct the Maneuver of a Platoon
071-420-0007	Conduct the Maneuver of an M2 BFV Rifle Team
071-420-0010	Conduct a Mounted Assault by an M2 BFV Platoon
071-420-0013	Conduct a Movement to Contact by an M2 BFV Platoon
071-430-0002	Conduct a Defense by a Squad
071-430-0003	Consolidate a Squad Following Enemy Contact While in the Defense
071-430-0004	Reorganize a Squad Following Enemy Contact While in the Defense
071-430-0006	Conduct a Defense by a Platoon
071-430-0007	Consolidate a Platoon Following Enemy Contact While in the Defense
071-430-0008	Reorganize a Platoon Following Enemy Contact While in the Defense
071-430-0017	Conduct a Defense by a M2 BFV Platoon
071-430-0024	Conduct a Defense by a M2 BFV Squad
071-440-0003	Conduct an Attack on a Building by a Squad During MOUT
071-440-0006	Conduct a Defense by a Squad During MOUT
071-440-0019	Conduct a defense by a M2 BFV Platoon During MOUT
071-440-0022	Conduct an Attack by an M2 BFV Platoon During MOUT
071-450-0005	Conduct a Screen by a Platoon
071-450-0011	Conduct an Antiarmor Area Ambush by an M2 BFV Platoon
071-450-0014	Conduct a Point Antiarmor Ambush by a Squad
071-450-0017	Conduct a Raid
071-450-0024	Conduct an Area Ambush by an M2 BFV Platoon
071-450-0027	Conduct a Relief
071-450-0030	Conduct a Passage of Lines
071-450-0035	Conduct an Area Ambush by a Platoon
071-450-0036	Conduct an Antiarmor Ambush by a Platoon
071-450-0037	Supervise Employment of Smoke
071-450-0038	Construct Field Expedient Flame Weapons
071-510-0001	Determine Azimuths Using a Protractor
071-510-0002	Compute Back Azimuths
071-600-0001	Destroy Supplies and Equipment
071-600-0005	Enforce Preventive Medicine
071-600-0006	Cross-Load Key Equipment and Personnel
071-600-0010	Supervise the Receipt of Supplies
071-620-0001	Plan for Decontamination Operations
071-620-0002	Employ NBC Defense Teams
071-710-0001	Maintain a Night Vision Sight AN/PVS-4
071-710-0002	Operate the Driver's Night Viewer AN/VVS-2 on a BFV
071-710-0003	Maintain the Driver's Night Viewer AN/VVS-2 (V3) on a BFV
071-710-0004	Supervise Use of Night Vision Devices
071-710-0006	Plan Use of Night Vision Devices

071-720-0006	Conduct Operation of a Patrol Base
071-720-0009	Conduct a Local Security Patrol
071-720-0012	Conduct a Zone Reconnaissance By a Platoon
071-720-0015	Conduct an Area Reconnaissance By a Platoon
071-720-0017	Conduct a Route Reconnaissance by a Platoon
071-730-0001	Emplace Pyrotechnic Early Warning Devices
071-730-0002	Recover Pyrotechnic Early Warning Devices
071-730-0005	Plan Employment of Field Expedient and Pyrotechnic Early Warning Devices
071-730-0006	Enforce Operations Security
071-730-0007	Supervise Employment of Field Expedient and Pyrotechnic Early Warning Devices
071-730-0008	Emplace Field Expedient Early Warning Devices
071-810-0001	Maintain an AN/PRC-126 Radio
071-810-0002	Operate an AN/PRC-126 Radio
071-810-0003	Construct a Field Expedient Antenna
071-810-0004	Maintain Intercommunications Set AN/VIC-1 on a Tracked Vehicle
071-820-0001	Operate Telephone Set TA-1/PT
071-820-0002	Install Telephone set TA-1/PT
071-820-0004	Recover Communications Wire Lines
071-900-0001	Prepare an Operation Plan
071-900-0002	Safeguard Classified Material and Documents
071-900-0003	Prepare a Battalion Operation Order
071-900-0004	Supervise Establishment of a Tactical Operations Center
071-900-0005	Supervise Displacement of a Tactical Operations Center
071-930-0001	Supervise Engineer Support
071-940-0001	Supervise the Distribution of Supplies
171-132-1001	Perform Emergency Evacuation Procedures on the M3 Bradley
171-132-1002	Stow Ammunition and Equipment on an M3 Bradley
171-132-1003	Abandon and Destroy an M3 Bradley
171-132-1004	Install/Remove an M240C Coaxial Machine Gun on an M2/M3 BFV

### **Occupy Assembly Area Tasks for IUSS**

051-191-1361	Camouflage Yourself and Your Individual Equipment
051-191-1362	Camouflage Equipment
071-311-2025	Maintain an M16A1/M16A2 Rifle
071-311-2029	Correct Malfunctions of an M16A1/M16A2 Rifle
071-311-2129	Correct Malfunctions of an M203 Grenade Launcher
071-312-3029	Correct Malfunctions of an M60 Machine Gun
071-326-0513	Select Temporary Fighting Positions
071-326-5703	Construct Individual Fighting Positions
071-329-1000	Identify Topographic Symbols, Colors, and Use Marginal Information
071-329-1001	Identify Terrain Features on a Map
071-329-1002	Determine the Grid Coordinates of a Point on a Military Map Using the Military Grid Reference System
071-331-0801	Use Challenge and Password
071-331-0815	Practice Noise, Light, and Litter Discipline
113-571-1016	Send a Radio Message
071-052-0003	Construct a Fighting Position for an M47 Medium Antitank Weapon

- 071-311-2006 Construct Field Expedient Firing Aids for an M16A1/M16A2 Rifle  
 071-311-2125 Maintain an M203 Grenade Launcher  
 071-312-3004 Construct a Fighting Position for an M60 Machine Gun  
 071-312-3025 Maintain an M60 Machine Gun  
 071-312-3003 Lay an M60 Machine Gun Using Field Expedients  
 071-312-4004 Lay an M249 Machine Gun Using Field Expedients  
 071-312-4025 Perform Operator Maintenance on an M249 Machine Gun  
 071-312-3007 Prepare a Range Card for an M60 Machine Gun  
 071-315-0003 Operate a Night Vision Sight AN/PVS-4  
 071-315-0030 Operate Night Vision Goggles AN/PVS-5  
 071-317-0000 Prepare an Antiarmor Range Card  
 071-328-5303 Practice Preventive Medicine  
 071-730-0008 Employ Field Expedient Early Warning Devices  
 113-588-1087 Install a Hot Loop  
 113-600-2007 Operate Telephone Set TA-312/PT  
 031-503-2008 Use and Maintain the M8A1 Chemical Agent Alarm  
 071-032-0006 Construct Field Expedient Firing Aids for an M203 Grenade Launcher  
 071-326-5503 Issue a Warning Order  
 071-710-0004 Supervise Use of Night Vision Devices  
 113-573-4003 Encode and Decode Messages Using KTC 600E Tactical Operation Code  
 113-573-4006 Use the KTC 1400D Numerical Cipher/Authentication System  
 113-573-8006 Use Automated CEOI  
 071-317-3324 Select Fighting Position for an M47 Medium Antitank Weapon  
 071-326-3049 Conduct Troop Leading Procedures for an Operation  
 071-326-5505 Issue an Oral Operations Order  
 071-410-0010 Conduct a Leader's Reconnaissance  
 071-730-0005 Plan Employment of Field Expedient and Pyrotechnic Early warning Devices  
 071-326-5761 Designate Primary, Alternate, and Supplementary Firing Positions  
 071-410-0012 Supervise Occupation of an Assembly Area  
 071-410-0020 Plan for Use of Supporting Fires  
 071-312-3026 Perform Function Check on an M60 Machine Gun  
 071-326-5775 Coordinate with an Adjacent Platoon  
 071-052-0001 Maintain an M47 Medium Antitank Weapon  
 071-052-0002 Maintain a Night Vision Sight, AN/PVS-5  
 071-311-2026 Perform a Function Check on an M16A1/M16A2 Rifle  
 071-312-4032 Prepare a Range Card for an M249 Machine Gun  
 071-317-3301 Conduct a Preoperations Inspection and Perform Operator Maintenance on a Dragon Tracker and Round  
 071-317-3307 Construct a Fighting Position (Dragon)  
 071-325-4425 Employ an M18A1 Claymore Mine  
 071-325-4426 Recover an M18A1 Claymore Mine  
 071-326-0520 Establish a Hot Loop with TA-1/PT Telephone  
 071-326-5502 Issue a Fragmentary Order  
 071-326-5625 Prepare and Issue an Oral Platoon Operation Order for an Offensive Mission  
 071-326-5701 Supervise the Preparation of a Squad-size Element's Defensive Position  
 071-326-5704 Supervise Construction of a Fighting Position  
 071-326-5705 Establish an Observation Post  
 071-326-5710 Designate Fighting Positions for Squad Members (Less Crew-Served Weapons)  
 071-326-5711 Designate Alternate and Supplementary Fighting Positions for Squad Members  
 071-326-5720 Prepare a Squad-Sized Element's Defensive Sector Sketch

071-326-5770	Prepare a Platoon Sector Sketch
071-326-5775	Coordinate with Adjacent Platoon-Sized Elements
071-326-5806	Plan and Conduct an Area Reconnaissance
071-328-5301	Inspect Personnel/Equipment
071-328-5302	Supervise Maintenance on Individual and TOE Equipment
071-331-0002	Conduct a Local Security Patrol
071-331-0001	Move as a Member of a Patrol
071-331-0003	Plan a Patrol
071-331-0011	Prepare Individual Equipment for Patrol
071-331-0804	Conduct Day and Night Surveillance Without the Aid of Electronic Devices
071-331-0820	Analyze Terrain
071-331-0852	Clear a Field of Fire
071-600-0005	Enforce Preventive Medicine
071-600-0010	Supervise the Receipt of Supplies
071-730-0006	Enforce Operations Security
071-820-0001	Operate Telephone Set TA-1/PT
071-820-0004	Recover Communication Wire Lines
171-121-1007	Perform Duties of a Road Guide
441-091-1101	Perform Search and Scan Procedures
441-091-1040	Visually Identify Threat Aircraft
441-091-1102	Engage Hostile Aircraft with Small Arms
031-503-1001	Maintain your M17 Series Mask with Hood
031-503-1003	Store your M17 Series Mask with Hood in Carrier
031-503-4002	Plan and Supervise Positioning of M8A1 Alarm System
113-587-2044	Operate Radio Set AN/PRC-77 or AN/PRC-25
113-587-3001	Perform Operator's Maintenance on Radio Set AN/PRC-77 or AN/PRC-25

## 6.0 Glossary

Aerobic: Requiring the presence of oxygen.

Alveolar air: The air present in the pulmonary alveoli that participates in gas exchange with the blood in the pulmonary capillaries.

Alveoli: The air sacs of the lungs in which most of the gas exchange occurs.

Anaerobic: Occurring in the absence of oxygen.

Anoxia: A deficiency of oxygen in the blood or tissues (hypoxia).

Basal Metabolism: The energy expenditure of the body under conditions of complete rest.

Calorie: The amount of heat required to raise the temperature of 1 kilogram of water 1° C.

Cardiac Cycle: The sequence of events in the heart-volume and pressure changes and valve actions during one complete period of contraction and relaxation.

Cardiac Output: The volume of blood pumped by each ventricle of the heart in 1 minute.

Dead Space: The combined volume of all the air passages in which no gas exchange occurs.

Dyspnea: Labored breathing associated with unpleasant sensation of breathlessness.

Ergometer: An apparatus for measuring the amount of work performed by a subject. The bicycle ergometer is a stationary bicycle in which the rear wheel is replaced by a heavy flywheel against which the subject performs work.

External Work: Movement of external objects by the contraction of skeletal muscles.

Fatigue: A diminished capacity for work caused by previous work. The term is also applied to accompanying subjective sensations.

Glycolysis: The breakdown of glucose to lactic acid.

Homeokinesis: Maintenance of steady state in the organism at elevated levels of metabolism.

Homeostasis: The normal constancy of the internal environment of the body.

Hyperpnea: Increased minute volume of breathing.

Isometric Contraction: A contraction in which a muscle is unable to shorten, the total tension developed eventually being dissipated as heat. No movement is produced and no work is performed.

Isotonic Contraction: A contraction in which a muscle shortens against a load, resulting in movement and the performance of work.

Kilocalorie per hour: Equals .1163 watts.

Kilocalorie per minute: Equals 6.978 watts = 6.978 joules per second..

Mechanical Advantage: The ratio of the length of the weight arm to that of the power arm in a lever. This determines the amount of load that can be moved by the application of a given amount of force.

Mechanical efficiency: The proportion of the energy requirement of an act that is converted into mechanical work. The mechanical efficiency of the human body ranges from 15 to 30%, according to the type of activity.

Metabolic Rate: The total energy expenditure of the body per unit of time.

Metabolism: The chemical reactions that occur in living tissues; the term is often confined to the oxidation's that are the ultimate source of biological energy.

Metabolite: One of the intermediate or final products in the metabolic breakdown of foodstuffs in the body.

Meter-kilogram: A unit of energy or work in a meter-kilogram-second gravitational system, equal to the work done by a kilogram-force when the point at which the force is applied is displaced 1 meter in the direction of the force; equal to 9.8 joules.

Normal Load: A light or moderate load of work in which the oxygen intake is adequate to supply the needs of the body.

Overload: A heavy work load in which the oxygen intake is inadequate to meet the requirement.

Oxygen Debt: The amount of oxygen required in the postexercise recovery period to reverse the anaerobic reactions of the exercise period. Quantitatively, the difference between the oxygen requirement of a task and the oxygen intake during performance of the task.

Phasic Contraction: A contraction of a muscle or group of muscles that results in movement.

Postural Contraction: A contraction of a muscle or group of muscle that results in no movement but serves to maintain a posture or attitude.

Power: The rate of performing work (force \* distance/time) or the rate of expending energy. The preferred unit of power is the Watt.

Prestart: Conditioned response to exercise resulting in elevation of body processes prior to activity.

Reflex: An involuntary motor response resulting from stimulation of sensory receptors.

Respiration: The sum total of the processes involved in the exchange of gases between an organism and its environment.

Starling's Law: The stroke volume of the heart is proportional to its diastolic volume. This results from the fact that the force of muscle contraction is increased by stretching of the muscle fibers.

**Watt:** The unit of power in the meter-kilogram-second system of units, equal to 1 joule per second. 1 watt = 1 joule per second = 0.1433 kilocalories per minute = 8.6 kilocalories per hour.

**Work:** The product of a force and the distance through which the force is applied for example, if a 1-pound weight is lifted a distance of 1 foot, the work performed is one-foot pound.

**Work Cycle:** A sequence of tasks, operations and processes, or pattern of manual motions, elements and activities repeated for each unit of work.

**Work Load:** The intensity of work, usually expressed in terms of foot-pounds or kilogram-meters of work per minute; sometimes the work load is expressed in terms of the oxygen requirement per minute.

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